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OPA Announces Higher Kraft Paper Prices

Amendments to Price Schedule and Regulations Increases Manufacturers' Prices of Kraft Wrapping, Bags, Liners and Other Important Grades — New Price Level Effective on April 1.

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 5, 1943—Specific maximum prices on a per-thousand-square-foot basis for the various calipers and weights of Fourdrinier kraft paperboard, at the manufacturing level, effective April 1, 1943, were announced today by the Office of Price Administration.

These detailed prices represent the $3.00 per ton increase in Fourdrinier kraft paperboard announced March 30, effective April 1.

Prices in Amendment No. 4

The detailed prices, contained in Amendment No. 4 to Revised Price Schedule No. 32 (Paperboard Sold East of the Rocky Mountains) follow:

Liners—0.016:	Price per M square feet
0.016—42 lb. Fourdrinier Kraft	$1.32
0.016—47 lb. Fourdrinier Kraft	1.48
0.016—50 lb. Fourdrinier Kraft	1.58
0.016—52 lb. Fourdrinier Kraft	1.64
0.016—56 lb. Fourdrinier Kraft	1.90
Liners heavier than 0.016:	
0.023—72 lb. Fourdrinier Kraft	$2.27
0.030—90 lb. Fourdrinier Kraft	2.84
Liners lighter than 0.016:	
0.009—32 lb. Fourdrinier Kraft	$1.09
0.012—33 lb. Fourdrinier Kraft	1.04
0.014—38 lb. Fourdrinier Kraft	1.20
0.014—43 lb. Fourdrinier Kraft	1.35
Corrugating Grades:	
0.009—26 lb. Fourdrinier Kraft	.82

To prevent these or any other increases from being passed on to the consumer, in April and May, Amendment No. 3 to Maximum Price Regulation No. 187 (Certain Paperboard Products) freezes raw material costs at March 31, 1943, levels from April 1 to June 1, 1943.

Prices in Amendment No. 6

Amendment No. 6 to Maximum Price Regulation 182 (Kraft Wrapping Papers, Certain Kraft Bag Papers and Certain Bags) also effective today, establishes the following maximum prices on various grades of kraft wrapping and bag paper per cwt. at the manufacturing level, these prices representing the $5 per ton increase announced March 30 on kraft wrapping paper and kraft grocers and variety and bag paper and bags, all prices being effective April 1, 1943.

Grades:	Maximum base prices per cwt.
Standard Kraft wrapping paper (30 pound basis weight and heavier)	$4.75
No. 1 Kraft wrapping paper (30 pound basis weight and heavier)	5.00
Superstandard Kraft wrapping paper (30 pound basis weight and heavier)	5.25
Imitation Kraft wrapping paper (40 pound basis weight and heavier)	4.50
Standard unbleached Kraft butchers wrapping paper (40 pound basis weight and heavier)	5.00
No. 1 unbleached Kraft butchers wrapping paper (40 pound basis weight and heavier)	5.25
Machine glazed Kraft wrapping paper (25 pound basis weight and heavier)	5.50
Standard Kraft bag paper (30 pound basis weight and heavier)	4.375
Variety Kraft bag paper (30 pound basis weight and heavier)	4.625
Machine glazed Kraft bag paper (25 pound basis weight and heavier)	5.25

B. W. Anderson Made Vice President

At the annual meeting of the stockholders and directors of Crocker, Burbank Papers Inc., B. W. Anderson was elected a vice-president. Mr. Anderson has been associated with the sale of Crocker, Burbank papers for a great many years.

He entered the paper business in 1901, as a country salesman for the Kansas City Paper House, and after twelve years, he affiliated himself with the Missouri Paper Company, Kansas City, Mo., which later became the Missouri-Interstate Paper Company.

In 1917 he moved to Chicago and was associated with J. W. Butler Paper Company. Several years later he became manager of the Whitaker Paper Company's Chicago branch.

Mr. Anderson's connection with the sale of Crocker, Burbank papers began in 1922 and he has been in Chicago since that time with Clarke & Co., and later with its successor, Crocker, Burbank Papers, Inc., as manager of their Chicago Office.

All other officers and directors of the corporation were reelected. The officers are Ralph M. Beckwith, president and treasurer; Norman Harrower, vice-president and assistant treasurer; H. T. Eaton, Arthur L. Bull and B. W. Anderson, vice-presidents. The directors are Ralph M. Beckwith, Douglas Crocker, Bigelow Crocker and Norman Harrower.

Safety Conference Slated to Meet in June

Annual Meeting Scheduled For May is Suspended in Favor of Curtailed Session on June 13 at Menasha—New Peavy Falls Power Plant Completed — Will Cooperate to Check Fire Damage.

[FROM OUR REGULAR CORRESPONDENT]

APPLETON, Wis., April 5, 1943—Although a decision had been reached to suspend the fifteenth annual Fox River Valley and Lake Shore Safety Conference scheduled at Appleton, Wis., in May, new arrangements have been made and it will now be a curtailed Sunday gathering, to be held June 13 at Menasha, Wis.

An invitation was extended by the Wisconsin Industrial Commission to the Twin City Safety Council, and plans were placed in motion last week. S. F. Shattuck, vice-president of Kimberly-Clark Corporation, Neenah, Wis., will serve as general chairman, and Edward Page of the same company, will be program chairman. Carl Christensen, Neenah, will be the secretary, S. E. Crockett, Menasha, treasurer, and H. L. Sherman, Menasha, chairman of registration.

The schedule will be one which will not interfere with industrial operation, and will omit such features as the annual banquet and parade. Registration will be scheduled at 11:00 a. m., and the conference will start at 1:30 p. m., with sectional meetings, one of which will be devoted to the pulp, paper and converting industries, scheduled at 3:00. A final general assembly will be held at 5:00 p. m. All sessions will be held in the high school at Menasha.

Peavy Falls Power Plant Completed

Completion of a $1,500,000 dam and generating plant at Peavy Falls, on the Michigamme River has given the Wisconsin Michigan Power Company, Appleton, Wis., another important link in its power supply for the Fox River Valley mills and other points. The plant was finished this year and is now in operation.

Construction of the Peavy dam was begun in September, 1941 by C. R. Meyer and Sons Company, Oshkosh, Wis. The Bacco Construction Company, Iron Mountain, Mich., had the contract for roads and excavation.

It was necessary to cut a 14-mile road through solid timber for truck-haul of all materials, since no railroad facilities reached the site. Much blasting of solid rock was necessary at the site, including 900 feet of tunneling.

The multiple arch type dam is 693 feet long, with five inclined arches resting on rock piers. The span of each arch is 75 feet, and the lowest elevation is 75 feet from the walkway at the top of the dam. A concrete flood spillway is provided, with structural radial gates. Adjacent to the arches is a truck-wheel equipped concrete intake, electrically operated. It allows passage of water to a concrete-lined tunnel. This carries the water 800 feet to a gate and surge chamber. The surge tank is of reinforced concrete with an inside diameter of 45 feet, and acts as a huge safety valve. At full flow, a velocity of 9.5 feet of water per second is developed, permitting the surge to rise 19 feet in the chamber before the energy of water in the tunnel is dissipated.

Two concrete-lined penstocks, each 12 feet in diameter and 85 feet long, lead from the surge chamber of the main tunnel to the hydro-electric units in the powerhouse downstream. The hydro units are of vertical shaft type, with Francis runners, controlled by actuator governors. Each unit is rated at 10,800 H. P. maximum and 9,975 at best efficiency. The associated electrical units are 7,500 KVA each.

All mechanical and electrical equipment, including the outdoor substation at Peavy, is remote-controlled from the company's hydro plant at Brule, but can also be locally controlled. Energy is generated at 6,600 volts, stepped up to 66,000 volts, and delivered into the system via two 66,000-volt transmission lines.

Flowage and storage area includes 5,300 acres. The plant will also benefit by the Michigamme Reservoir, completed in May, 1941, which also supplies three additional company plants. It impounds 113,800 acre-feet of water, of approximately five and a quarter billion cubic feet. This project represented an outlay of about half a million dollars. Since the gates at Peavy Falls were closed about two months ago, some 870 million cubic of storage capacity has been added to the reservoir, giving a total storage above Peavy and the Menominee River plants of 6,120,000,000 cubic feet.

About 700 tons of steel were spared from the project by blasting a tunnel through rock instead of building overhead steel penstocks. Substitute materials or salvage steel used in other parts of the system saved another 250 tons. Included in the salvage was a quanttiy of steel rails taken from abandoned street railways of the company at Appleton, Wis.

Estimated annual production of the Peavy plant, operating at head from 95 to 85 feet is 42,915,000 KWH. The capacity of 15,000 KVA is based on a one-third load factor, meaning a substantial value through ability to use the station as a peak carrier for any emergency in other areas served by the company.

Whiting-Plover Increases Wages

Employees of the Whiting-Plover Paper Company, Stevens Point, Wis., have been granted a wage increase of four cents per hour for all hourly paid male workers, and three cents for female workers. The increase was approved by the War Labor Board, and is retroactive to October 1, 1942. This brings the new base pay to 65 cents per hour for men and 50 cents for women. About 220 employees were affected.

A joint application for the increase was made by the company and Plover Local No. 370, International Brotherhood of Papermakers. The company is now operating its mill on a 48-hour week basis, paying time and one-half over 40 hours.

Cooperate to Check Fire Damage

Lest valuable pulpwood and timber supplies be destroyed by fire spring and summer, governmental agencies are pooling their efforts as a part of the state's civilian defense production. The U. S. Forest

Service, the Indian Service and the Wisconsin Conservation Commission are enrolling thousands of men as fire fighters, and will be supplied with identification cards and armbands. Many have received special training. These forces will work under the direction of Neil Le May, chief forest ranger, who has been named deputy state coordinator.

Jesse M. Halderley Commissioned Captain

Jesse M. Holderby, coordinator of research for the Wisconsin Sulphite Manufacturers Committee, has been commissioned a captain in the Sanitary Corps of the Army. Since the committee was formed sometime ago to work out a plan for the elimination of stream pollution for sulphite liquor, Mr. Holderby has been stationed at the Institute of Paper Chemistry, Appleton, Wis., where the research and experimental plant operations are being conducted. He formerly was superintendent of the municipal sewage disposal plant at Neenah and Menasha, Wis.

Bemis Bro. Bag Co. Expand in South

To meet the rapidly increasing war needs for packaging in the South, the Bemis Brothers Bag Company is increasing its production of multiwall bags in that section by relocating at Mobile, Ala., existing equipment to produce sewn and pasted, valve and open-mouth, multiwall paper bags. This move will result in the saving of transportation facilities so needed for the war effort.

Operations to be started within a few weeks in a plant adjacent to the paper mill of the Hollingsworth & Whitney Company, will make available to multiwall bag users in the South the Bemis Company's long experience in the design and manufacture of paper bags combined with the outstanding kraft paper of this modern mill.

The starting of multiwall paper bag manufacture at Mobile will in no way interfere with the ability of the other five Bemis multiwall factories, located at Peoria, Ill.; East Pepperell, Mass,; St. Helens, Ore.; San Francisco; Wilmington and Los Angeles, Cal., to take care of their customers. In fact, it will enable Multiwall bag users in the South and elsewhere to get better service than they have ever had before. The Bemis Mobile plant will serve the entire southern territory stretching along the Atlantic seaboard to include North Carolina and west through Texas. C. E. Hayward, who has had long experience in the manufacture of bags, and who has been with the Bemis Company for 18 years, will manage the plant. Shelby W. Brown, who for many years has traveled the southern territory as a representative of the Bemis factory at New Orleans, will be the sales manager.

Multiwall bags are now used for packing many products such as fertilizer, cottonseed meal, chemicals, resin, asphalt, and many agricultural and food products so important to winning the war,—to mention only a few. New products are continually being handled successfully in these bags.

Morris L. Ellis & Co. Liquidate

[FROM OUR REGULAR CORRESPONDENT]

BOSTON, Mass., April 5, 1943—Morgan L. Ellis & Co., Inc., 368 Congress street, in business for a considerable period, handling a general line of paper, is liquidating on account of labor shortage.

Transportation Situation Tight

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 7, 1943—The transportation situation affecting the paper industry was reported as tight at a recent meeting of the WPB Pulp and Paper Transportation Advisory Committee.

It was recommended that the industry continue its efforts to conserve transportation by loading cars as heavily as possible, loading and unloading without delay, and by cleaning cars at once so that they will be ready for immediate re-use.

While average loads have increased to a considerable extent recently, it was felt that much more could be accomplished within the industry itself to conserve transportation. In November, average car-loadings for different types of paper showed an increase of from 10 to 35 per cent over average figures for 1938, and from 10 to 31 per cent over 1941, the greatest gains being made in printing paper loading.

Among the recommendations intended to increase car loadings and expedite car handling, were: avoidance of car detention, careful routing to keep freight out of congested areas, elimination of unnecessary hauling, and proposed standards for loading various kinds of paper, paperboard, and paper articles for rail shipment. The recommendations as to standards, which were submitted to the Office of Defense Transportation, will enable shippers of paper products to contribute considerably to the maximum freight car loading order of the O.D.T., it was explained by F. E. Hufford, Government presiding officer of the meeting.

While reports from many paper companies showed that cars were being loaded and unloaded promptly, it was pointed out that the matter of car detention must be dealt with more vigorously and that no unnecessary delays should be permitted. Storage of goods in railway cars must be stopped, and embargoes will be used to control car detention.

Other matters discussed by the Advisory Committee included an anticipated serious delay in the movement and delivery of bulk commodities by rail due to decreasing car supply, increased time of turn around and slowing of transit, all tending to offset the gains effected in heavier loading. Efforts also are being made to avoid delays in loading and unloading of trucks and thus make for efficiency in that field of transportation.

Ways and means of combating reduced inventories, caused by the long transit time requirements in moving wood pulp, were also discussed and reports on delays occurring in the future will be made to the Pulp and Paper Division.

The next meeting of the advisory committee is scheduled for April 27 and 28 in Washington.

Marshall Dana Joins Armed Forces

Temporary leave of absence has been granted by the New York and Pennsylvania Company, New York, to Marshal M. H. Dana, member of the company's sales organization and director of advertising, in order to permit him to join the armed forces. Mr. Dana is now undergoing basic training preparatory to attending officers' training school for service with the U. S. Navy.

Mr. Dana has represented the company in the New York sales territory and has in addition supervised the company's advertising program.

Chicago Reports Need for Higher Prices

Increasing Labor and Other Costs Place General Paper Merchants in Difficult Position—Upward Adjustment of Paper Prices Declared Necessary to Establish Equitable Level — Other News.

[FROM OUR REGULAR CORRESPONDENT]

CHICAGO, Ill., April 5, 1943.—The consensus of opinion in the Chicago paper market is that over-all developments in all phases of paper manufacturing and distributing are going to force a general revision of price ceilings in the trade or cause a definite mortality in the ranks of the paper industry. The wave of buying which has been charatceristic of the market for many weeks continues to be the outstanding news but back of it is an increasing accounting of the slim profits and profiitless prosperity within the "squeeze" itself. Higher taxes, increasing labor costs, unavailability of raw materials, transportation difficulties, pressure from raw material sources—these have all combined to make the picture dark unless the Office of Price Administration sees fit to recognize the "cost plus" factor in the industry itself.

Kraft Continues Strong

Kraft markets continued very strong during the week while groundwoods and newsprints found buyers still clamoring for business on almost any reasonable delivery basis. Book and cover papers remained at the peak point while all sulphites were in a similar category. Boards were strong. Waste papers in general showed a firm tone though better weather and a readjustment in the wage situation in the yards was helping the situation somewhat.

Get Job Tax Reductions

Illinois employers now have begun to feel the benefits of the experience rating factor within the State's unemployment insurance Act. The Illinois Department of Labor announced this week the new job contribution rates based on the stability records of industry over the past three years—the basis for present rates. The fight for experience rating, which has been a feature of legislative consideration in Illinois since 1936, seems to have been worthwhile and many a paper jobber and retailer will find himself saving some real money because of the rating provision. For wholesale and retail trades in the State the following figures were released. A total of 37.30% in this class earned a rate of 0.5% as compared to the former 2.7%; 22.82% earned the new rate of 1% while 10.07% went down to 1.5%. Those who reached the 2% basis totaled 10.65% of the total in the wholesale and retail trades while 6.63% earned 2.5%. Only 3.74% went to 3% while only a fraction over 8% went up to the 3.6% figure as a penalty for instability in employment. Thus nearly 80% in this classification earned a reduction and 70% of this group got below the 2% figure. The Department also announced that manufacturers also participated in the reductions to a degree not actually expected by some students of employment procedure and experience.

N.P.T.A. Head Seriously Ill

Members of the paper industry and particularly those identified with the National Paper Trade Association, will be grieved to learn of the serious illness of Corwine E. Roach, recently elected president of the N. P. T. A. Mr. Roach was stricken with a paralytic stroke on March 28 and on April 1 was reported as still unable to have any visitors. His associates in the Capitol City Paper Company, of which Mr. Roach is the head, reported that he had been working very hard not only on his own business affairs but in the new program of the National Paper Trade Association and on civic matters in Springfield which have always been beneficiaries of his time and effort. As chairman of the Legislative Committee of the Illinois Chamber of Commerce, Mr. Roach likewise had a busy session of the State legislature to occupy a part of his time.

Paper Payrolls Up In Illinois

Both employment and payrolls increased in the paper goods, printing and publishing industries in Illinois for January 15, 1943 compared to the experiences of the month previous. The 270 reporting firms showed an increase of 1.4 per cent in employment and 3.5 per cent in payrolls during the period. The paper box, bag and tube divisions within the report showed an actual increase of three per cent in employment and of 0.7% in payrolls as compared to the above over all figures.

Issues New Casein Prices

To iron out price inequities between various sellers, the Office of Price Administration today scrapped previous ceilings set last fall on industrial casein and whey powder for feed purposes under the individual "freeze" technique and replaced them with specific dollars-and-cents maximums five to ten per cent higher.

The new ceilings—which exceed slightly the previous average levels prevailing during the September 28-October 2, 1942, base period—may encourage producers now selling farm separated cream to shift to the sale of whole milk. This should result in some step-up in casein output, as well as a larger whey powder production.

The new specified maximums on industrial casein apply at all stages of manufacture, f.o.b. shipping point. Ceilings on whey powder, also on an f.o.b. shipping point basis, cover sales at manufacturing, wholesale and retail levels.

The move is taken in Amendment No. 8 to Maximum Price Regulation No. 289 (Dairy Products), effective April 8, 1943.

The following tabulation lists the ceiling prices on the various types of casein, f.o.b. shipping point at the manufacturer level:

Types of casein:	Cents per Pound
Wet curd acid—(dry basis)	14¾
Wet curd rennet—(dry basis)	16¼
Dry acid	17¾
Dry rennet	19¼
Processed acid	21
Processed rennet	22½

Instrumentation Studies XLIV*

Penetration of papers by water vapor. Part I.

General discussion of the present status of the measurement of water vapor permeability

By the Staff of The Institute of Paper Chemistry

Abstract

The salient facts about water vapor permeability are briefly discussed. The currently employed gravimetric method is carefully considered, and it is concluded that this method is subject, under certain circumstances, to large errors. The change in volume of the testing unit and the corresponding change in buoyant force occasioned by change in barometric pressure are subjected to mathematical analysis, in the light of which tares employed in weighing are discussed. Under certain conditions, the volume of the testing unit may change because of swelling of the test specimen. Due to the accidental existence of small "pinholes" or leaks, the weight of air confined in the testing unit or in the tare may change. In consideration of these defects, there appears to be no general procedure which will ensure, under all conditions, a good order of accuracy where highly moistureproof sheets are tested. Where it is desirable to employ water or saturated salt solutions in the testing unit, the diffusion resistance of the air space between the test specimen and the surface of the water or salt solution renders the test very insensitive where membranes of low moistureproofness are tested. In order that the property might be more fully explored, a different method is suggested for future investigations. The suggested method is of the "comparison" type, in which the water vapor permeability of the test specimen would be compared with that of a standard of diffusion resistance. Diagrams of suggested equipment are presented and technical details are discussed.

Introduction

Because of their use in packaging and housing, papers designed to resist the passage of water vapor are of considerable importance. Accordingly, the Subcommittee on Instrumentation Research of the American Paper and Pulp Association has considered it advisable to include in the current instrumentation program a study of methods for the measurement of *water vapor permeability.*

A study of the literature on the measurement of this property in paper, rubber, regenerated cellulose, and other enveloping materials reveals that sufficient work has been carried out to establish the relative importance of the variables affecting a determination of moistureproofness. Abrams, Brabender, and Chilson *(1-4)* have contributed very significantly to the development of methods satisfactory for the routine measurement of water vapor permeability of moistureproof papers, and have carefully investigated the influences of several variables. Carson *(5)* has prepared an excellent review of methods to 1937, wherein he discusses the factors influencing tests for moistureproofness and presents an interesting theoretical description of the transfer of water vapor through a web. During the past four years a few articles of interest have appeared *(3, 4, 6-9).*

It has become very clear that a method cannot be considered satisfactory for mill use if it does not satisfy all of the following requirements:

1. The apparatus employed must be sufficiently inexpensive for routine testing—i. e., it should be possible to employ a reasonable number of testing units simultaneously.

2. The method must be free of the errors which have been recognized in the literature on the subject, and preferably permit of testing of specimens under various conditions of relative humidity, moisture content, and temperature approximating the conditions of use.

3. The procedure must not be complex and time-consuming. Reference is made here to the consumption of time by an operator handling the equipment and making observations, and not to the total elapsed time of test of specimens. As regards total elapsed time, investigations *(1, 10, 11)* have shown that specimens of good moistureproofness must be subjected to testing conditions for many hours before the rate of transfer of moisture assumes a constant value, even when the permeability characteristics of the material are nearly constant with time. The slow equilibration is mainly associated with the slowness of change of moisture content of the test specimen following the change in environment from the conditioning atmosphere to the testing apparatus. In certain cases, however, depending upon severity of conditions, the equilibration time may be lengthened by gradual change in permeability characteristics of the membrane material *(10).*

The method which has been developed for the paper industry *(4)* satisfies the above requirements fairly satisfactorily where truly moistureproof papers are tested, but quite considerable room for improvement remains in this type of instrumentation. It would be of great significance if a method could be developed which would sensibly reduce the total time of test, for then many more specimens could be tested (with a given number of testing units) and the lag between production and results of tests could be decreased. If it is the nature of a moistureproof membrane material to equilibrate slowly in a test of any conceivable type, then the testing time cannot be materially decreased unless one is interested only in a crude check on the moistureproofness of paper in production. Using the present method, even though the rate of equilibration were rapid, a test period of many hours would often be required to obtain a reasonable change in weight, for it is not uncommon to observe changes in weight of the testing system as small as one or two mg. in a 24-hour period. For various reasons to be discussed, weight changes of this order of magnitude cannot be accurately interpreted, even though the balance employed is itself accurate to 0.1 mg. Ordinary moisture-pervious pa-

* This report is one of a series issued as a part of the Instrumentation Program of the American Paper and Pulp Association.

per equilibrates rapidly, and transmits water vapor at a relatively large rate but, as will be shown later, the testing of such paper by the currently employed method leaves a great deal to be desired.

The literature describes and is suggestive of methods which seem sufficiently promising to receive thorough investigation on the instrumentation program. In several instances equipment has been described which is complex and not suited for use in a paper mill testing station, but which involves principles of operation that might be incorporated to good advantage in a method of the kind sought. This report is written primarily for the purpose of discussing the presently employed method and a proposed new method for a more complete investigation of the property. Before entering upon this discussion, it seems desirable to recall some of the facts concerning the water vapor permeability of paper and other enveloping materials.

General Discussion of the Property

The water vapor permeability (hereinafter referred to as "WVP") of a material is not, as commonly supposed, uniquely related to porosity—e. g., an "air-tight" membrane may, or may not, be very permeable to water vapor. Rubber furnishes an often quoted example of this interesting fact. Relative to its impermeability to air, a thin rubber sheet will transmit water vapor at a rate which is surprisingly large. The same situation obtains for regenerated cellulose and paper made from highly beaten pulp. In short, moisture is transmitted through a paper or other cellulosic sheet, by mechanisms other than that of simple diffusion through pores or open spaces; among the mechanisms which Carson *(5)* believes are often of greater importance than simple diffusion is adsorption of water molecules followed by migration along internal surfaces of separation between micelles.

The rate of transfer of water vapor is not, in general, directly proportional to the difference in partial pressure of water vapor or to the difference in relative humidity across the test specimen. Charch and Scroggie *(10)*, Abrams and Brabender *(2)*, and Brabender *(3)* have found that, for a given difference in relative humidity, the rate of transfer of moisture is very appreciably greater at very high relative humidities than at low humidities. As an example of the magnitude of this effect, Brabender *(3)* reports that, for two lacquer coatings, the rate of transfer for the relative humidities 100-50 per cent was approximately double that for the relative humidities 95-50 per cent, although the ratio of the relative humidity differences was only 10:9. In some materials, particularly at low humidities, rate of transfer of water vapor is very nearly proportional to the difference in partial pressures (whether this difference is produced by varying relative humidities, or by holding the relative humidities constant and varying the absolute humidities), whereas in other materials this is not the case. Often the transfer will be proportional to difference in partial pressures *only* when the difference is varied by changing the temperature and *holding the relative humidities constant.* Recent work *(18)* has yielded data which illustrate this very well. A desiccant was placed inside the testing units and the ambient relative humidity was varied from low to high values. The test specimens included both polar and nonpolar membranes of good moistureproofness. When the rate of gain of moisture by the testing units was plotted against the relative humidity of the surrounding atmosphere, quite different classes of curves were obtained: Those for nonpolar membranes were straight lines showing a uniform rise with increasing ambient relative humidity, whereas the curves for polar membranes were strongly curved, exhibiting a steep rise at the higher relative humidities. As a result of the difference between the character and slopes of these two classes of curves, it is possible for a polar membrane to have a higher water vapor permeability than a nonpolar membrane at high relative humidities, and a very much lower permeability at low relative humidities. As a consequence of these phenomena, the WVP ranking of a group of samples at one temperature and for one pair of relative humidities is apt to be significantly different from that under another set of conditions. Accordingly, it is highly desirable to test specimens for WVP under conditions of temperature and humidity approximating those of typical use, and data on WVP should be accompanied by a complete statement of the conditions of temperature and relative humidities employed in the test.

In some applications of a moistureproof paper liquid water may be in contact with one side of the sheet. This must be carefully differentiated from the situation in which conditions are exactly the same except for the absence of liquid water, which is replaced by air at 100 per cent relative humidity. Even though the sheet resists the passage of liquid water, the WVP will usually be higher when a film of water, rather than saturated air, is in contact with one side of the sheet. This effect has a bearing upon proper simulation of conditions of use in testing and, as Charch and Scroggie *(10)* point out, may be a source of error. In any method of testing in which a relative humidity of 100 per cent is intended to be in contact with one face of the specimen, the temperature must be carefully controlled to obviate the possibility of water condensing upon the specimen. In the testing of opaque papers, an error having this origin could easily pass unnoticed.

As mentioned above, a desirable feature of a new method would be a shorter elapsed time of test. It has been indicated, however, that a steady rate of transfer of water vapor through some materials is not attained until many hours after the start of the test. Tressler and Evers *(12)* have found that the WVP of certain heavily coated paperboard does not assume a constant value until after the passage of three days, and they employed periods of test up to five days. However, the results reported by Abrams and Chilson *(1)* on moistureproof papers of ordinary thickness indicate that the WVP becomes constant after about 10 hours, and it now appears to be common practice to make rate determinations after the test specimens have been under testing conditions for one day. The equilibration time for ordinary, moisture-pervious papers is usually quite short. It is evident that the time for equilibration must be determined for each type of paper, and for certain papers it is possible that no conceivable method would measure WVP both quickly and accurately.

The Present Method

The reader is referred to the excellent report by Brabender *(4)* for a detailed description of the method now commonly employed in the paper industry. The noteworthy features of this method are its direct-

ness and simplicity of equipment and procedure. Due to the low cost of the testing units, a reasonably large number of specimens can be tested simultaneously.

In this method, the test specimen is sealed with wax to a light alloy cup or glass crystallizing dish, after water, or a saturated salt solution, or a desiccant has been added to the cup, the particular choice depending on the use conditions to be simulated. According to present recommendations, an air space 25 mm. thick exists under the specimen in the event that water or a saturated salt solution is used in the cup. When a desiccant is used in the cup, a sufficient amount is employed to form a thick layer, and the cup is inverted so that the desiccant rests upon the inner surface of the specimen; in this case the cup is supported in such manner that a free stream of air can be directed upon the outer surface of the test specimen. In any case, a rapidly moving stream of air is passed over the outer surface of the specimen, for it has been found that WVP data depend upon rate of movement of ambient air when this rate is insufficiently high *(1)*. The testing units must be handled in the constant temperature, constant humidity room of the paper mill laboratory, or in a special constant temperature, constant humidity cabinet.

Using a tare volume about the same as that of the testing unit, the cup assembly is weighed from time to time on an analytical balance reading to 1 mg. The weight increment (decrement) is then plotted against time, and the WVP is obtained from the slope of the latter, straight part of the resulting curve. It should be mentioned at this point that the linear portion of the curve occurs after a period of time which depends upon the test specimen. If the specimen is not highly moistureproof, the curve may become linear only a few minutes after initiating the test and, if a desiccant is used in the cup, so much water may be taken up by the system after several hours that the curve is no longer linear and the test no longer valid. In other words, the slope of the linear part of the curve must be taken at a time depending upon the degree of moistureproofness of the specimen, and not invariably 24 hours after starting the test. The final result may be expressed in a variety of ways, one of the most easily visualized and handled being to compute to grams transferred per square meter per day of stated relative humidities and temperature.

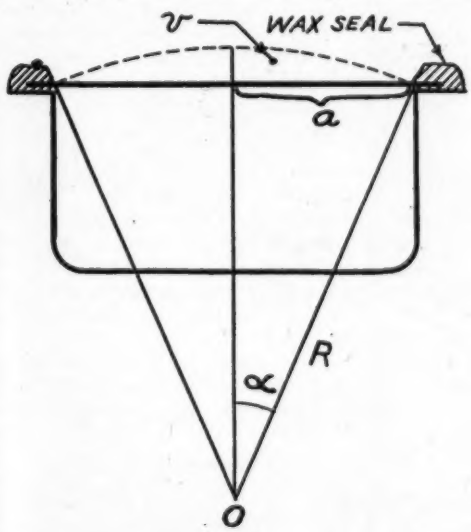

FIG. 1

Increase in Enclosed Volume (Exaggerated) Due to Reduction in Atmospheric Pressure

Most errors have been eliminated, but some sources of occasionally large errors still remain. The several sources of error in this method have been discussed to some extent *(4, 5)*. While most of these have been eliminated, there still remain at least two which, under certain conditions, may be responsible for significantly large errors. These are:

1. *Weighing.* Advances in papermaking have reduced the WVP of moistureproof papers to such an extent that it is not uncommon to deal with vapor transmission rates of the order of 5 mg. per day for the actual area of specimen used in the test. For papers of considerable interest, then, one has the problem of accurately measuring day-to-day weight changes of only a few mg. Granted that the analytical balance may be reliable to 0.1 mg. in the measurement of weight differences, the errors introduced by certain variables are actually large in comparison with the quantity measured. These variables will now be considered.

Change of atmospheric pressure has been considered in discussions of errors, but it appears that no one has studied this subject in detail. The use of a tare of weight and volume about the same as that of the testing unit has been suggested, and such a tare is used in the current test. Carson *(5)* has stated the likelihood of overcompensation where a tare of fixed volume is used. It develops, as shown below, that strong over-compensation obtains in most cases.

Let us suppose that atmospheric pressure decreases slightly. The test specimen will bulge outward, as shown in great exaggeration in Fig. 1. If the test specimen were a membrane having extensibility but no strength, it would bulge out to increase the enclosed volume by the maximum possible amount, v_0, corresponding to the reduction in pressure from the initial value, P, to the final value, P'. In this hypothetical case the enclosed volume would increase by exactly the amount required to offset the reduction in buoyant force associated with the decrease in density of the air, and it would be unnecessary to employ a tare of volume equal to the enclosed volume of the testing unit; in fact, the use of such a tare would introduce an error amounting to $v_0\ d$ grams, where d is the density of air.* In the actual case, the specimen bulges out until the air pressure inside the cup is equal to the sum of the reduced atmospheric pressure P' and the pressure p due to tension stresses in the specimen. If the enclosed volume of the cup is V when the specimen is flat, then Boyle's law requires that

$$PV = (P' + p)\ (V + v). \qquad (1)$$

Referring to Fig. 1, v is the volume between the base of the cone having its vertex at O, and the spherical surface represented by the dotted line. Integration shows that this volume of bulge is

$$v = (\pi/3)\ a^3\ [2(1 - \cos\alpha) - \sin^3\alpha \cos\alpha]/\sin^3\alpha. \qquad (2)$$

The pressure p due to tension stresses in the test specimen is given by the equation,

$$p = (T_1 + T_2)/R = (2\overline{T}/a) \sin\alpha, \qquad (3)$$

* A tare of weight and density the same as the weight and *average* density of the cup and contents (*not* including the volume of the enclosed air) would be used if we wished accuracy in absolute values of weight; however, we are only interested in differences in weight and such a tare could, in the ideal case under discussion, be dispensed with if we could tolerate an error of the order of 0.2 mg. (for a weight of 50 g. and change in atmospheric pressure of 1 per cent).

where T_1 and T_2 are the forces per unit width of specimen in the two principal directions of the specimen, $\overline{T}$ is their average, R is the radius of curvature of the bulge, which is closely spherical in shape *(13)* and, as indicated in Fig. 1, a is the radius of the opening of the cup.

The tension stresses may be related with the fractional increment in area of the sample which, in turn, is approximately twice the linear extension. The areal increment (fractional) may be shown to be

$$e = (1 - \cos \alpha)/(1 + \cos \alpha). \quad (4)$$

The extensions involved in actual work are so small that one may assume direct proportionality between them and the average force per unit width in the specimen, $\overline{T}$. As illustrations, we may consider two cases, the first for papers of medium strength, and the second for papers comparable in strength to that of heavy kraft paper:

$$\overline{T} = 50{,}000\ e \text{ g./cm.} \quad (5)$$
$$\overline{T} = 500{,}000\ e \text{ g./cm.} \quad (5')$$

Equation (5) is equivalent to saying that the average tension in the specimen is 1000 grams per cm. width when the linear extension is 1 per cent, and e is 2 per cent, whereas equation (5′) states that there would be 10,000 grams per cm. width for 1 per cent extension. Writing $T = Ke$, where K is, respectively, 50,000 and 500,000 g./cm. in the above examples, and substituting in Equation (1) the values from Equations (2), (3), and (4) for v, p, and e, we obtain Equation (6):

$$\frac{(P - P' - [2K(1 - \cos\alpha)\ \sin\alpha]/[a(1 + \cos\alpha])\ V = [(\pi a^3)/(3\sin^3\alpha)]\{P' + [2K(1 - \cos\alpha\ \sin\alpha]/[a(1 + \cos\alpha)]\} \times [2(1 - \cos\alpha) - \sin^2\alpha\cos\alpha]. \quad (6)$$

Inserting specific values for P, P', K, a, and V, one may solve Equation (6) to find sin α and cos α, and then substitute these values in Equation (2) to calculate v, the volume of bulge. Three cases of interest have been considered; the results of the calculations are given in Table I. For the purposes of illustration, a change in atmospheric pressure of 1 per cent was assumed. This change is fairly typical; over a period of a few days, however, atmospheric pressure may change by 3 per cent or more. Numerical values chosen for the computations are:

A. $P = 1{,}000$ g./cm.^{2} $V = 236$ cm.^{3}
$P' = 990$ g./cm.^{2} $a = 5$ cm.
$K = 50{,}000$ and $500{,}000$ g./cm.

B. $P = 1{,}000$ g./cm.^{2} $V = 200$ cm.^{3}
$P' = 990$ g./cm.^{2} $a = 3.5$ cm.
$K = 50{,}000$ and $500{,}000$ g./cm.

TABLE I.—ERRORS DUE TO ONE PER CENT CHANGE IN ATMOSPHERIC PRESSURE

K g./cm.	α deg.	v cc.	$(v_0 - v)$ cc.	$(v_0 - v)d$ mg.	vd mg.
		A			
0	2.08	2.38(v_0)	0.00	0.00	2.9
50,000	2.04	2.33	0.05	0.06	2.8
500,000	1.78	2.03	0.35	0.42	2.4
		B			
0	5.16	2.02(v_0)	0.00	0.00	2.4
50,000	4.18	1.64	0.38	0.46	2.0
500,000	2.66	1.04	0.98	1.2	1.3

The first column of Table I gives the tension in the specimen per unit width, per unit areal increment (fractional). Thus the first rows of parts A and B present data for resilient but indefinitely weak membranes; the second rows, sheets of medium strength; and the last rows, sheets of high strength. The second column gives the angle α (*see* Fig. 1). The third column presents the calculated volumes of bulge of the specimen; the first volume is v_0 and represents the free expansion of the enclosed air in the cup for the 1 per cent reduction in atmospheric pressure. The fourth column presents the differences between free and actual expansions. The values of this column are multiplied by d, the density of air, to obtain the figures of the next column, which are the *change in buoyant force acting upon the cup assembly and are therefore the errors due to the 1 per cent change in atmospheric pressure when* no *tare of total enclosed volume V is used.* In contrast, the last column presents the errors involved when a tare of fixed volume V is used; it will be seen that these errors, of the order of 2 or 3 mg., *are of the same order as the weight difference per 24 hours which one would observe for a good moistureproof sheet.* In the recommended procedure for the method under discussion, the weight of the system is plotted against time, and a straight line is drawn through the points. Hence, the discrepancies of the order of a few mg. are deviations from the straight line and, if the variations in atmospheric pressure are frequent, small, and random, a fairly reliable result will be obtained. However, it may fortuitously happen that atmospheric pressure will change in a uniform manner during the period of measurement, thereby introducing a possibly serious error. Furthermore, the existence of this source of error will usually require that the period of test be carried on long beyond the point corresponding to equilibrium. This discussion presumes that a tare of *fixed* volume is used.

Where tares have been used, it may have sometimes happened that close compensation was effected, for tares comprised of testing cups closed with shim metal have been used. If it happened that the extensibility of the shim metal was comparable with that of the specimens the error would, of course, have been negligible. Theory shows that the extensibility of the shim metal need only approximate that of the test sample to result in fairly close compensation, and hence it is possible that one tare may be adequate for a large number of samples.

In the case of heavy paperboard, the small extensibility and greater stiffness would seem to call for the use of a tare of fixed volume.

The rather involved Equations (2) and (6) can be put into approximate forms, in view of the smallness of the angle α. With fairly good accuracy, these equations become, respectively,

$$v = (\pi a^3/6)\ \sin\alpha, \text{ and} \quad (2')$$
$$(K/12y)\ \sin^4\alpha + (K/2a)\ \sin^3\alpha + (aP'/6y)\ \sin\alpha = P - P', \quad (6')$$

where y is the depth of the testing cup and the other symbols have their previous meanings. The latter equation is most easily solved by trial and error. In connection with this discussion, another quantity of interest is the height of rise or depression, b, of the center of the test sample. When the angle is fairly small, $b - (\frac{1}{2})\ a\ \sin\alpha$, so that the volume of bulge may be written as approximately $v = (\frac{1}{3})\pi a^2 b$.

In view of the surprisingly large volumes of bulge which have been calculated and shown in Table I, it seemed worthwhile to perform an actual test of the theory. A heavy moistureproof sheet (110 lb., 25x40—500) comprised of kraft paper laminated with asphalt was sealed to a glass crystallizing dish of ordinary size, $a = 4.5$ cm., and $y = 4.8$ cm. The edge of the crystallizing dish was ground square, and the sealing was done with a rosin-beeswax mixture. The unit was placed in a large vacuum desiccator,

which could be connected to an aspirator or compressed air line. By means of a suitable arrangement of a gas washing bottle, the reduction or increase in pressure could be held at 4 inches of water (equivalent to a 1 per cent change in atmospheric pressure). A very small wire, bent into a shape similar to that of a thumb tack, was placed on the test specimen in such manner that the end of the wire pointed upward, and served as an indicator. This wire indicator was imaged, by means of a lens placed at a circular outlet in the wall of the desiccator, on a distant scale. In this way a magnification of about sixteen times was obtained for the movement of the center of the test specimen. Several measurements gave an average height of depression (or elevation), $b = 0.080$ cm., with an average deviation of 0.017 cm. Corresponding to this is a volume of bulge, $v = 1.70$ cm.^{3}. By applying various loads to strips of the paper in a tensile tester, it was found that the force per cm. width per unit extension was 2,600,000 g./cm. This figure is the average for the machine and cross-machine directions. If the stress per unit strain is the same in a linear strip as a diaphragm (in which the strain is approximately the same in all directions), which would not be quite the case, the previously defined K would be one-half the above figure, or 1,300,000 g./cm. (Division by two is necessitated by reason of the fact that areal extension is twice the corresponding linear extension.) Substitution of this value of K in Equation (6′) leads to $\sin a = 0.0325$, and to $b = 0.073$ cm., which agrees within experimental error with the measured value, 0.080 cm.

Finally, the small changes in relative humidity which normally occur in a well regulated testing room might cause variations of the order of 1 mg. in the moisture content of the test specimen. The magnitude of this effect would depend upon the rate of drift of relative humidity and upon the nature of the moistureproof sheet—i.e., upon the position of the moistureproof film (s) in (or on) the paper web. There would seem to be four cases of interest: *(a)* a paper web coated on one side, with the coated side facing the interior of the cup, or *(b)* the same, with the coated side facing the outside atmosphere; *(c)* two paper webs laminated with a central, moistureproof film; *(d)* a paper web coated on both sides. In cases *(a)* and *(c)* the effect could be large, of the order of 1 or 2 mg., the actual value depending upon the drift in relative humidity and the weight and hygroscopicity of the specimen. In cases *(b)* and *(d)* the effect might be negligible, particularly in the event that the relative humidity drifted to either side of a definite mean value several times during the course of a day. However, the change in WVP with change in relative humidity is apt to be of equal, or greater, importance than errors arising in change in weight of the test specimen.

(To be Continued)

New Sweden "Thickol" Plant

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 7, 1943—An unofficial report to the Department of Commerce states that a new plant at Alfredshem in northern Sweden will have an estimated production of 200 tons of "thickol" annually as a by-product of wood pulp manufacture. The present output is 100 kilograms a day.

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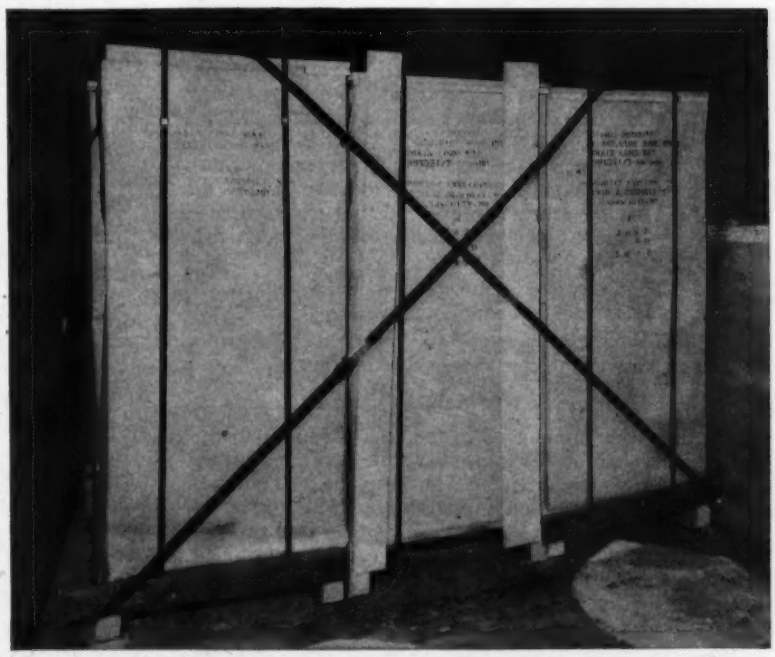

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PROMPT SHIPMENTS To War Production Plants

THE STANLEY WORKS STEEL STRAPPING DIVISION NEW BRITAIN, CONNECTICUT

Argues Against Federal Control of Forests

Leader of the Opposition in Quebec Legislature Asserts Forestry Reserves Belong to Province—Suggests Taking Over U. S. Markets Formerly Held by Scandinavian Nations — Other Late News.

[FROM OUR REGULAR CORRESPONDENT]

MONTREAL, Que., April 5, 1943—Maurice Duplessis, the leader of the Opposition in the Quebec Legislature, argued before the legislative assembly a day or two ago that the federal government had no right to interfere with newsprint production in the Province of Quebec, "because the forestry reserves, like other natural resources, belong to the province."

Calling for the production of all correspondence exchanged between the federal and Quebec governments with reference to the pulp and paper industry, he said: "It is ridiculous to claim that newsprint production is being restricted because of a lack of electricity. We have more electricity than any other province. We have more than we know what to do with.

"The restrictions will complicate post-war plans. They have put hundreds of men out of work and caused the value of the Canadian dollar to decline in the United States because our exports have decreased."

He suggested that the province make every effort now to take over the United States markets formerly held by the Scandinavian nations, adding, "The bureaucrats say they want to save electricity but paper mills work every Sunday and have a holiday in the middle of the week. That isn't observing the Sunday labor law."

Hon. Leon Casgrain, Attorney-General, said that pulp and paper mills were allowed to work Sundays when federal authorities showed that there were 350,000 more horsepower available than on weekdays.

"Quebec agreed to allow the mills to operate Sundays, on three conditions. The conditions were:

"1—That the workers were told that it was necessary to operate Sundays because of the electricity shortage;

"2—That the workers were given time off to attend to their religious duties;

"3—That the workers be only asked to work Sundays as long as the electricity shortage existed."

New Brunswick to "Manage" Forest Lands

It has been announced in the New Brunswick legislature that in order to preserve the forest resources of the province and to sell them to the best advantage, full time trained foresters are to be appointed to manage the timber lands and see that they are put to the best possible use, also that, a more determined effort will be put under way to market products of the forests according to grades and that, in order to encourage reasonable conservation, a proposal to tax wild lands according to yield, rather than by acreage will be considered.

It was also reported that the total value of forest products in New Brunswick in 1942 was $56,000,000. There was a sawmills' cut of 300,000,000 feet and the value of pulp and paper products was $30,000,000.

Indianapolis Continues Active

[FROM OUR REGULAR CORRESPONDENT]

INDIANAPOLIS, Ind., April 5, 1943.—Continued activity was in evidence last week for most of the paper list with prices firm and for the most part bouncing along the ceilings that have been fixed by OPA. There are many here who believe production costs, increasing wholesale costs and other increasing cost items, including taxes, will make it imperative for some adjustments to be made in ceiling prices.

Producers of paper board and kindred items in this territory seem to be faring better than most other paper manufacturers. The main reason for this is the fact thta much of their output is going into plants making defense items. Paper cartons and boxes are in big demand, perhaps more so than at any other time in the history of this territory.

Output of waxed paper containers has been curtailed to some extent this spring. Due to radical rationing of ice cream sales, there being no package ice cream available in local drug stores or other retail outlets, the usual increase for waxed containers from this source will be cut this spring. However, demand from the dairies for paper milk cartons shows little decrease. The fact that dairies have reinstated a deposit on all glass milk bottles has caused the consumer to turn again to the paper carton which may be thrown away when used.

Some inquiries were received last week for building paper and roofing, but it is not thought the demand this year will be greatly inexcess of that last year, when the volume was exceptionally low. Prices will be slightly higher. However, most jobbers and retailers have large stocks on hand.

No change was seen in the fine paper market. Demand continued good last week for all grades. Newspaper publishers of the state continued to show little concern over decreased stocks available to them or the probability of a further cut in supplies.

Demand for rags last week continued steady with prices firm to strong. Paper stock demand was active for virtually all grades.

To Develop New Uses of Paper

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 7, 1943—Frederick G. Barber of Alexandria, Virginia, paper expert, has been employed to develop new uses of paper to replace more critical materials, the Navy Department has announced.

Formerly consultant to the pulp and paper unit of the Office of Civilian Supply, War Production Board, Mr. Barber will assume the post of assistant to the chief of the container division of the Office of Procurement and Material at the Navy Department. The container division was established nearly a year ago to serve the Navy, Marine Corps and Coast Guard in their numerous problems of packaging.

TAPPI Notes

The fall meeting of the Technical Association of the Pulp and Paper Industry will be held in Chicago, Ill., in September. The dates and hotel headquarters have not yet been selected.

Gordon Morseth, formerly of the Puget Sound Pulp and Paper Company, is now with the Detroit Sulphite Pulp and Paper Company as sulphite superintendent.

C. A. Southwick, formerly of the General Foods Corporation, is now director of research and development for Shellmar Products Company, Mt. Vernon, Ohio.

Earl P. Lovenheim, formerly of the Continental Paper Company, is now chemist for the Ancram Paper Mills, Ancram, N. Y.

Reuben B. Robertson, Jr., vice president and general production manager of the Champion Paper and Fiber Company, is now a captain in the Army Service Force, Washington, D. C.

R. M. Drummond of the International Paper Company, Glens Falls, N. Y., has succeeded Henry Perry of the J. P. Lewis Company as chairman of the TAPPI Mechanical Pulping Committee.

George H. McGregor of the Forest Products Laboratory, Madison, Wis., has succeeded D. C. Porter of the Kimberly-Clark Corporation as chairman of the TAPPI Acid Pulping Committee.

Werner Kaufman of Pupfer Brothers Company, New York, N. Y., has succeeded J. D. Davis of Dill & Collins, Inc., as chairman of the TAPPI Coating Committee.

R. H. Torrey of the Riegel Paper Corporation, New York, N. Y., has succeeded Allen Abrams of the Marathon Paper Mills as chairman of the TAPPI Bacterial Control Methods Committee.

National Starch Starts New Plant

Henry F. Schricker, governor of Indiana, on March 19 broke the seal of the first carload of corn to enter the conveyors of the newly constructed Indianapolis plant of National Starch Products, Inc., thereby starting production on an additional 100,000,000 lbs. of corn starch annually for the war effort. Operations will be on a continuous 24 hour a day, seven days a week basis.

From this source of raw material will be processed the major portion of adhesives, dextrines, and starch derivatives produced by National's Adhesives Division for the packaging, wrapping, and sealing of army, navy, and lend-lease materials, as well as those for domestic consumption. National's starches are also used extensively for food and laundry purposes, and in the manufacture of textiles and paper.

Governor Schricker was one of a number of prominent officials who attended the informal opening ceremonies. Others included Robert H. Tyndall, mayor of Indianapolis; C. D. Alexander, of the Indianapolis chamber of commerce, who acted as master of ceremonies; high-ranking army and navy officers; and representatives of various federal agencies, manufacturing, educational, agricultural, and civic groups. Many executives and employees of National Starch Products, Inc., were also present, headed by Frank K. Greenwall, president; Arthur D. Fuller, executive vice-president, and Chester A. Gage, vice-president in charge of sales.

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FINANCIAL NEWS

New York Stock Exchange

High, Low and Last for Week Ending April 3, 1943

STOCKS

	High	Low	Last
A. P. W.	2¾	2⅝	2⅝
Armstrong Cork Co.	34⅞	32¾	34½
Celotex Corp.	14	13¼	13¾
Celotex Corp., pf.	88¾	87¾	88½
Certain-Teed Products Corp.	6¼	5⅞	5⅞
Certain-Teed Products Corp., pf.	65¼	59	61¾
Champion Paper & Fibre Co.	20½	19¼	19⅝
Champion Paper & Fibre Co., pf.	103½	103	103
Congoleum Nairn Co.	21⅜	20	20⅞
Continer Corp. of America	22⅞	22	22
Continental-Diamond Fibre Co.	14	13	13¼
Crown-Zellerbach Co.	14⅜	13⅞	14¼
Crown-Zellerbach Co., pf.	90¾	88¾	90½
Dixie-Vortex Co.	13½	13⅜	13½
Dixie-Vortex Co.—A	40½	39¾	39¾
Flintkote Co.	19¼	18⅜	18⅜
Flintkote Co., pf.	102	102	102
Robert Gair	3¾	3⅛	3¼
Robert Gair, pf.	12⅞	12½	12½
International Paper Co.	12⅜	11½	11⅞
International Paper Co., pf.	59	57¼	57¼
Johns-Manville Corp.	85½	84	84¾
Johns-Manville Corp., pf.	....	....	....
Kimberly-Clark Corp.	29⅜	29	29
MacAndrews & Forbes	23¾	23½	23½
MacAndrews & Forbes, pf.	....	....	....
Masonite Corp.	35⅞	35½	35¾
Mead Corp.	9⅞	9½	9½
Mead Corp., pf. A—6%	86¼	83½	84½
Mead Corp., pf. B—5½%	75	75	75
Paraffine Companies, Inc.	41	40¼	40½
Paraffine Companies, Inc., pf.	....	....	....
Rayonier, Inc.	13½	13¼	13¼
Rayonier, Inc., pf.	29	28¼	29
Ruberoid Co.	24¾	23⅞	24½
Scott Paper Co.	39¼	38	38
Scott Paper Co., pf.	113	112½	113
Sutherland Paper Co.	31¼	30	30½
Union Bag & Paper Corp.	11½	10⅝	11
United Paperboard Co.	5½	5¼	5⅜
U. S. Gypsum Co.	71¾	67¾	69
U. S. Gypsum Co., pf.	....	....	....
West Virginia Pulp & Paper Co.	16	15¼	15½
West Virginia Pulp & Paper Co., pf.	107½	107½	107½

BONDS

Abitibi Pulp & Paper Co. 5s '53	62½	62½	62½
Celotex Corp. 4½s '47	102¾	102	102
Certain-Teed Products Corp. 5½s '48	99⅜	98½	99
Champion Paper & Fibre Co. 4¾s '50	....	....	....
International Paper Co. 6s '55	106¾	106	106¼
International Paper Co. 5s '47	104	103½	104
Mead Corp. 3½s '53	....	....	....
West Virginia Pulp & Paper Co. 3s '54	....	....	....

New York Curb Exchange

High, Low and Last for Week Ending April 3, 1943

STOCKS

	High	Low	Last
American Box Board Co.	6¼	6⅛	6⅛
Brown Co., pf.	....	....	....
Great Northern Paper Co.	35	34¾	34¾
Hummel-Ross Fibre Corp.	5⅛	4¾	4¾
National Container Corp.	10¾	10½	10⅝
St. Regis Paper Co.	2⅞	2⅝	2¾
St. Regis Paper Co., pf.	129	126	129
Taggart Corp.	3¼	3⅛	3¼

BONDS

American Writing Paper Co. 6s '61	91⅞	91	91⅞

Gaylord Nets $1.55

The Gaylord Container Corporation for 1942 reports a net income of $1,108,543, equal, after preferred dividends, to $1.55 a share on the common stock. This does not take into account the post-war credit of excess profits taxes, amounting to $176,400, or 33 cents a common share. In 1941, net income was $1,349,125, or $1.98 a share, after deducing a contingency reserve of $400,000, or 74 cents a share. Federal income and excess profits taxes last year were $2,369,500, against $2,140,000 in 1941. Gross sales in 1942 were $30,010,234, the highest in the company's history, and compare with $27,632,897 in 1941.

War Increases Kimberly-Clark Sales

Increased sale of crepe wadding products, chiefly as a result of government demand, and machine shop production on war products were responsible for net sales of Kimberly-Clark Corporation, Neenah, Wis., reaching a total of $41,163,000 for the year 1942, according to the annual report submitted to stockholders. This compares with $36,959,000 for the year 1941.

Stockholders were also informed that the company's research facilities were employed during the last year in cooperation with various government agencies endeavoring to find substitutes for critical materials such as steel, aluminum, etc. It was said, for instance, that an impregnated sheet of paper has been developed that can be used for lining an expandable gas tank for bombers, and for making bags for the transportation of gas and oil.

Puget Sound Nets $2.48

The Puget Sound Pulp and Timber Company reports a net profit of $878,611 for 1942, which amount includes $176,206 realized from life insurance; net profit was $1,076,178 in 1941 and $795,553 in 1940.

This independently audited result for 1942 represents $2.48 a share of common stock, after preferred dividends; excluding the insurance item, the net equalled $1.94 per common share. Net available to common amounted to $3.08 a share in 1941 and $2.40 in 1940.

More business was done in 1942 than in any previous year, but higher costs of doing business coupled with a lower average net sales price through price control regulations prevented establishing a net profit record.

Mead Corp. Profits Off

The Mead Corporation, including operations of the Escanaba Paper Company since its acquisition on August 31, 1942 reports for 1942 a net income of $1,357,470, after provision of $2,343,519 for Federal and State income and Federal excess profits taxes, equivalent to $1.42 a share of 693,600 shares of common stock, compared with $2,109,785, or $2.66 a share, on 625,000 common shares, after taxes of $1,650,923 in 1941. Net sales last year were $33,858,432, against $32,452,149 in 1941.

Gair Co. Re-Elects Officers

At the annual meeting of stockholders of Robert Gair Company, Inc., held on March 25, Henry J. Sargent, of Boston, was elected a director to fill a vacancy in the board of directors.

Flambeau Co. Earns $2.10

The Flambeau Paper Company for 1942 reports a net income of $140,690, equal to $2.10 a share on 49,218 shares of common stock, compared with $200,950, or $3.22 a share, in 1941.

Army-Navy E to Shartle Bros.

The highly prized Army-Navy E, symbol of efficiency in the execution of Government contracts was presented to Shartle Brothers Machine Company, Middletown, Ohio, on April 6, 1943.

Present at the colorful ceremony, planned for the event, were representatives of the Army and Navy, mill representatives and other honored guests, as well as the entire Shartle organization and the members of their families.

The award to Shartle Brothers was for quality of work done and the volume and speed of production. Both were accomplished under trying circumstances by men keenly aware of the seriousness of the emergency and willing to labor long and hard for Victory. Many time-slips for 72 and 84 hours testify to the dogged determination of men to "see this thing through"—come what will.

Operations run approximately 97% war contracts, and are conducted on a round the clock schedule. These contracts cover many different items, among them jordans for the manufacture of nitrocellulose, shafts for Liberty ships, Covettes, etc.

Shartle Brothers established in 1889, devotes its peacetime engineering and fabrication facilities entirely to the manufacture of paper mill machinery and systems. Over the years numerous major developments stand to their credit, prominent among them the perfection of the first practical plunger stock pump; also the principle of continuous beating, in contrast to batch beating, exemplified in the Shartle breaker beater.

Officers of the company are Herman L. Kutter, president of the Black-Clawson Company, Hamilton, Ohio of which Shartle is a division; Homer L. Martindale, vice-president and general manager; Adam E. Bridge, vice-president in charge of Sales; Clifford Crawford, vice-president and chief engineer.

B. C. Pulp Co. Reports Reduced Output

The B. C. Pulp and Paper Company, operating mills at Port Alice and Woodfiber, B. C., report production is sharply reduced due to log shortage and the necessary replacement of a large proportion of its employees. This result was notwithstanding increased plant capacity. Costs of operation have increased, while selling prices have remained generally unchanged, according to President Lawrence Killam.

In 1941 the company's two plants operated at capacity with output in excess of that of the previous year.

Operating profits in 1941 were $3,292,690; but last year due to the enforced curtailment of operations, gross profits dipped to $1,729,356.

Net profits of B. C. Pulp & Paper, after payment of bond interest, taxes and writeoffs, are shown at $241,981, compared with $601,160 in 1941—a decline of almost 50%.

Interest on the company's 6 per cent. first mortgage gold bonds was paid in full during the year. No dividends on the preferred or common shares were paid. During the year $1,839,751 was paid on account of previous and current income and excess profits taxes. A reserve of $420,000 was provided for 1942 to cover income and excess profits taxes, and the statements are still subject to adjustment pending decision regarding tax liability accrued in the years 1940, 1941 and 1942.

The heat is on in our foundry. Tons and tons of metal are flowing. Large and small castings are pouring out for the war machine. More men were needed to keep production moving, new equipment was added, new technical skill employed. It's production for Victory now. But there'll come a day when the output of our foundry will be going into the reconstruction after the war. Paper mills will need new machinery and many replacements. We will have the men and the facilities then to give you fast service and the finest castings.
CASTINGS
THE APPLETON MACHINE COMPANY
APPLETON · WISCONSIN

PAPER
TRADE JOURNAL
Title Reg. U. S. Pat. Off.
Henry J. Berger
EDITOR

Vol. 116 April 8, 1943 No. 14

COMING EVENTS IN PAPER INDUSTRY

New England Section. Technical Association of the Pulp and Paper Industry—Third Friday of each month at the Roger Smith Hotel, Holyoke, Mass.

Delaware Valley Section. Technical Association of the Pulp and Paper Industry—First Friday of each month at the Engineers Club, Philadelphia, Pa.

Lake States Section. Technical Association of the Pulp and Paper Industry—Second Tuesday of each month at the Conway Hotel, Appleton, Wis.

Kalamazoo Valley Section. Technical Association of the Pulp and Paper Industry—First Thursday of each month at the Park, American Hotel, Kalamazoo, Mich.

American Pulp and Paper Mill Superintendents Association, Twenty-fourth Annual Convention, Commodore Hotel, New York, June 15-17.

RISING PRICES

Any serious inquiry into the economic problem of rising prices brings out the point that governmental policy exerts good or bad effects upon the economic balance. For years, much has been heard of the merits of a controlled economy. Now that the war effort has created a controlled economy, results are not quite as expected. One obvious cause of the only partial success of the Administration's controlled economy is that it got off to a poor start. That is, while the practical procedure would be to control all factors which contribute to rising prices and inflation, industrial wages and farm prices were not included. These are the most important factors, and those cited as primarily responsible for the failure of the Administration's plans to function in the best interests of all.

In reference to inflation, well considered opinion in some quarters does not regard the present price level as inflationary to an alarming extent. It is merely considered as reflecting the very high rate of industrial activity. A potential threat to a highly inflationary level is present, and if that level is reached it will impose hardship on the majority of people and seriously interfere with the conduct of the war. It has also been pointed out that the Administration's attempts to keep farm prices down, with less assertive measures taken to stabilize factory wages at a like moderate level, has already created a lopsided situation, not likely to be entirely remedied because no serious attempt is being made to correct the basic cause of the current unbalanced economic situation.

In commenting on the labor and wage situation, the March 30 issue of *The Guaranty Survey*, published by the Guaranty Trust Company of New York called attention to the labor situation in part, as follows: "The threat of a strike involving 450,000 workers and capable of seriously crippling war industry within a short time has hung over the country in recent weeks, as a result of the failure of representatives of bituminous coal miners and operators to reach an agreement on the terms of a new contract. The miners demand a wage increase of $2 a day, although they concede that no such increase is permissible under the 'Little Steel' formula that has guided the wage policy of the National War Labor Board since last summer. They propose that negotiations be continued for a month beyond the expiration of the present contract on March 31 if such a continuation is necessary, but only on condition that any agreement be made retroactive to that date. The operators originally declined to accept the retroactive proposal and appealed to Government officials for intervention . . . The importance of the coal wage controversy lies not only in its potential direct threat to war production but also in its possible bearing on the Government's wage policy and the price stabilization program as a whole . . . Labor members of the National War Labor Board recently filed a petition asking 'that the allowance for maladjustments or increase in cost of living be increased from 15% to a new realistic figure based upon the actual cost of living to the worker.' On March 22, the board, by a vote of 8 to 4, rejected this petition and reaffirmed the 15% formula."

Relating to total earnings and the cost of living the statement of the board "also emphasizes the need for distinguishing between hourly wage rates and total earnings. *The Survey* goes on to say: 'It is not the average hourly rate, but the amount of his pay check which determines the ability of a worker to maintain or increase his standards of living . . . By and large, the average earnings of the workers of the country have increased at a rate far in excess of the increase in cost of living . . . Since the cost of living has advanced only approximately 20% since January, 1941, and actual earnings have increased more than 50% in the same period, the workers still have a cushion of more than 30% to draw upon before they will be called upon to make any real sacrifice on account of increased costs of living' ".

In quoting the position of the public members of the board, represented by Wayne L. Morse, *The Survey* states in part: "If the only grounds for asking for a wage increase are the grounds that the cost of living has risen above the 15% formula, we do not propose to vote for an increase on those grounds. 'If the other agencies of the Government 'fail to control the cost of living, with the result that the cost of living reaches a point where labor cannot maintain a decent cost of living, necessary to maintain maximum war production, then I will vote to break that ceiling; but that will be only after other agencies of the government have failed to carry out their job.' The fact that 'the cost of living has gone up 7% above the 15% is not an argument sufficient in weight, in my judgment, to break that formula yet'. To do this it will be necessary 'to prove that the cost of living has gone up to such a point that, on the basis of cost of living alone, labor cannot maintain

maximum production of war materials and live on the wages they are receiving.'"

In its discussion of administrative remedies, *The Survey* declares that "it is evident that any price or wage solution to the problem involves a basic conflict between two vital war objectives—the stimulation of production and the stabilization of prices and the cost of living. This conflict could be avoided by a system of compulsory allocation of manpower . . . Perhaps the least harmful means of meeting the situation by voluntary methods would be to permit a rise of farm wages and meet the additional cost by the use of subsidies . . . If the conflict must be forced and a choice made between the objective of increased production and that of price stabilization, the latter must probably give way, even at the risk of a serious advance in the cost of living."

F. W. Walker at Ogdensburg

[FROM OUR REGULAR CORRESPONDENT]

OGDENSBURG, N. Y., April 4, 1943—F. W. Walker, president of the Cleveland Container Company, left here last week after spending some time inspecting his firm's interests and expressed satisfaction with the progress being made in making the plants ready for occupancy. The firm recently bought the Fell Foundry and the former plant of the International Harvester Company, and is now negotiating for a lease of the old silk mill in Ford street. Crews of workers are busy at both the silk mill and the harvester building preparing for occupancy and it now appears likely that at least one will be in production early in May. About 100 workers, mostly women, are to be given employment. The company will produce paper and fiber containers.

Production Ratio Report*

(Production as per cent of six-day capacity)

COMPARATIVE WEEKLY SUMMARIES

Current Weeks—1943		Correspondinge Weeks—1942	
February 20	89.0	February 21	103.8
February 27	90.9	February 28	104.5
March 6	89.5	March 7	102.7
March 13	89.8	March 14	101.9
March 20	88.4	March 21	103.6
March 27	*89.7*	March 28	103.4

COMPARATIVE MONTHLY SUMMARIES

Year	Jan.	Feb.	Mar.	Apr.	May	June	July
1942	104.5	103.9	102.9	100.4	95.3	87.4	75.8
1943	87.5	*88.7*	....	....	....	....	....

Year	Aug.	Sept.	Oct.	Nov.	Dec.	Year Avg.
1942	80.8	82.8	90.6	86.9	80.1	90.4
1943	....	....	....	....	....	....

COMPARATIVE YEARLY SUMMARIES

	1936	1937	1938	1939	1940	1941	1942	1943
Year to Date..	75.9	89.3	66.8	79.4	85.9	88.9	103.7	*88.6*
Year Average..	80.4	79.8	71.5	83.4	85.6	97.4	90.4	...

* Based on tonnage reported to American Paper and Pulp Association. Does not include mills reporting to National Paperboard Association, except in isolated cases where both paper and paperboard are produced and separate tonnage figures are not readily available. Does not include mills producing newsprint exclusively.

PAPERBOARD OPERATING RATIOS †

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year Avg.
1937	83	89	89	91	88	80	69	77	72	70	57	47	75
1938	56	63	63	60	60	59	59	60	70	73	67	61	64
1939	65	73	76	74	69	73	68	77	82	91	88	77	77
1940	78	75	74	76	82	85	77	79	78	85	82	77	78
1941	81	88	89	89	91	94	92	98	95	99	98	90	92
1942	102	101	101	95	82	72	68	75	76	81	82	77	84
1943	86	*88*	..	..	..	..	..	..	..	..	..	..	..

Week ending Feb. 20, 1943—91
Week ending Feb. 27, 1943—94
Week ending Mar. 6, 1943—93
Week ending Mar. 13, 1943—93
Week ending Mar. 20, 1943—92
Week ending Mar. 27, 1943—95

† Per cents of operation based on "Inch-Hours" reported to the National Paperboard Assn.

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OF AMERICAN PULP

TO
BRITAIN
SOUTH AMERICA
AND ALL WORLD MARKETS

LYDDON
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NEW YORK CITY

1943 EDITION

LOCKWOOD'S DIRECTORY

OF THE PAPER AND ALLIED TRADES

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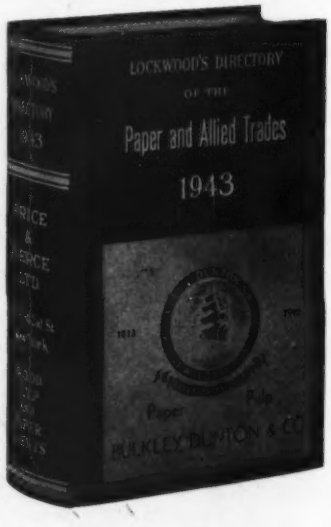

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Section of the
TECHNICAL ASSOCIATION
OF THE PULP & PAPER INDUSTRY

Edited by R. G. Macdonald, Secretary

Deinking and Reuse of Old Papers*

By Frederic C. Clark[1]

Abstract

The growing shortage in bleached sulphite and sulphate pulps will be severely felt by the paper industry in 1943. This shortage in raw materials for the manufacture of paper may be alleviated by an increase in the use of old white papers, magazines, and book stock for reuse into white pulps. There is available a much greater supply of old paper stock than has ever been collected. Approximately 35% of all paper and board made comes back for reuse. If this could be increased to 45% it would result in the collection of 1,500,000 tons of additional material, and this would produce over 100,000 tons of deinked white pulp and 1,000,000 tons of material suitable for the manufacture of board and containers.

The paper discusses briefly the rotary boiler and the circulating tank processes, pointing out the faults of each and possible steps for improvement. Some mills with very small additions to their present equipment could produce good deinked old paper stock. Conversion costs are discussed briefly.

The purpose of this article is to call the attention of the paper industry to possible drastic reductions in the supply of pulps; to point out briefly that with suitable effort it is possible to collect far greater quantities of old papers than have ever been collected before; and to very briefly discuss the processes by which old white papers are made suitable for reuse.

The paper industry is today facing a definite shortage in bleached pulps. This shortage is the result of the use of a large tonnage of bleached sulphite pulp in the manufacture of explosives, and because of government curtailment in wood pulp production in order to divert manpower from logging and pulpmaking to more essential war industries. Still further curtailments in pulp production seem imminent. The extent of curtailment is dependent upon war requirements and available manpower. A long war may see still greater quantities of pulp allocated to war needs, and more men taken from pulp and paper mills.

Pulp and Pulpwood Conditions

It is estimated that the 1943 cut of pulpwood will be drastically reduced over that of 1942. In 1942 the United States used 17,500,000 cords of wood, including imports of Canadian pulpwood. The estimated available pulpwood supply for 1943 is set at about 14,000,000 cords, or a reduction of approximately 20%. Probably the largest part of this shortage in pulpwood will be reflected in reduced sulphite pulp production. These estimates indicate that the industry must take every possible step to reduce waste in operations, and to reuse a greater quantity of old papers now going to incinerators or to city dumps.

Great Britain imports practically all of her pulp and, therefore, has had to meet an extreme pulp shortage. This has resulted in very drastic cuts in the use of every kind of paper; in addition there is being collected and reused all waste paper under strong mandatory regulations. In normal times Great Britain has consumed a relatively small amount of old papers. Today, however, every scrap of paper and board is scrupulously saved and turned back for reuse. Many British paper mills have had to devise equipment for handling old papers, because both new and used equipment has long since become unobtainable.

We in the United States are not faced with a pulp shortage as serious as that in Great Britain, but conditions here are such as to warrant careful study well in advance of serious need. Some mills may find it desirable to put in equipment for deinking old papers and in this way provide pulp to meet their production requirements. In other mills very little additional equipment will be needed. The important point is for each mill to study its own problem so that suitable plans may be ready if and when required.

Old Papers Utilization

The three major problems of the paper industry are raw material, labor, and maintenance supplies. Of these three, raw material, or the lack of it, is the most serious. Our only way of solving the problem of curtailed pulp production is by increasing the use of old papers.

At the present time approximately 35% of all paper and board produced is returned for reuse. It seems reasonable to assume that this 35% could easily be increased to 45% which would be equivalent to adding over 1,500,000 tons of waste paper to our national stock pile. This in turn is equivalent to adding over 100,000 tons of deinked pulp to the national pulp supply, and over 1,000,000 tons of raw material suitable for board and container uses. The collection and distribution of this additional quantity of old papers would require the development of a well thought out plan to ensure the extra material col-

* Presented at the Annual Meeting of the Technical Association of the Pulp & Paper Industry, Hotel Commodore, New York, N. Y., Feb. 15-18, 1943.

[1] Member TAPPI; Consulting Engineer, 479 Moody St., Waltham, Mass.

lected by the public being quickly transported to the mills where it might be required.

There must be formulated a workable, practical plan by which this large quantity of waste paper may be regularly collected, sorted, baled and shipped to the paper mills. In 1938 Loddengaard *(1)* presented before TAPPI a thoroughly constructive discussion of this whole waste paper collection problem. The suggestions he made then are of even greater importance at this time. The industry could well afford to give serious study to this published article and from it develop a comprehensive plan that would benefit both the mill and the waste paper dealer.

In this article Loddengaard points out that it is possible to secure carefully sorted grades if the mill will continually inspect deliveries and insist on the grading specifications set up by the National Association of Waste Material Dealers. He speaks of practices by the mill and by the packer which are not conducive to good understanding between the two, of the need to stabilize prices, and of maintaining large inventories at the mill at certain seasons of the year. Many other suggestions are well discussed by Loddengaard and the article is strongly recommended to the industry for careful, detailed study.

The American public in recent months has been taught the importance of saving things formerly wasted. We have been taught to flatten out our old tin cans, to collect old rubber, iron, brass, and aluminum, to save cooking fats, to gather old clothing, to save old paper and board, and to have these things ready for designated agencies. Today so much is being saved that the resultant accumulation seems to be greater than can be handled in the normal channels. We hear reports of waste paper dealers not being able to handle this large accumulation, and of quantities of paper being burned on the dumps. Any plan that is set up to increase the supply of waste papers must consider the entire problem from the point of origin of the waste material on through to the paper mill.

During the past two years the averagt annual production of all kinds of paper and board has been 17,000,000 tons. Of this quantity approximately 5,900,000 tons of all kinds of paper have been returned for reuse. This is a 35% return of all paper and board produced. What becomes of the remaining 65%, equivalent to nearly 10,000,000 tons? Not more than 2,000,000 tons per year goes into building and roofing papers, books, documents, wallpaper, and other kinds having a permanent use. There is available approximately 8,000,000 tons of uncollected paper and board from which it should be possible to greatly increase the annual collection. For every 1500 pounds of waste paper and board reused, there is a saving of one cord of wood. Saving and reusing much greater quantities of our waste paper is an immediate necessity as a wartime measure, and very much in the interests of national economy.

Deinking Methods

The process of deinking old papers is essentially a laundry process. The paper must be wet with water so it may be defibered. The rosin size of the paper and the binder of the ink must be softened or dissolved so the ink pigment may be set free as a nonsticky substance. The washing process that follows is one in which large quantities of water are put through a pulp mat before the mat is thick enough to act as a filter for the pigment particles.

A wide variety of deinking processes have been practiced by the industry, and the literature is full of historical descriptions. Some of these old processes are still in use.

Today two processes are in general use for deinking old papers, each with some modification to suit the preference of the individual mill:

1. Rotary boiler for cooking, followed by means of agitation for complete defibering.
2. Circulating tanks to combine cooking and defibering by rapid agitation of the stock as performed by various devices at a wide range of consistencies to ensure complete defibering.

Each process and its modification has its advocates. Differences in quality and cost of product, due to process, are relatively small *if* each is properly operated and each has been laid out for minimum labor and horsepower consumption. The great difference that sometimes occurs in a mill-to-mill comparison is due to poor layout of equipment and violations of good laundry practice. A poor layout of equipment may require extra labor for handling raw material, and much unnecessary pumping of low consistency stock. Good laundry practice requires the least amount of chemicals and the lowest operating temperature. Cooking old papers at high temperature (240°-250° F.) and with excessive alkali results in forming a dark colored cooking liquor which acts to stain the fibers and causes excessive loss of fiber during the cooking process, excessive use of chlorine for bleaching, and a further loss during the bleaching stage. The resultant pulp is soft, low in strength, and when made into paper will quickly discolor with age. There are mills today using rotary boilers for old papers where cooking is carried on for 8 to 10 hours at 40 to 50 p.s.i. steam pressure and with a high alkali percentage. This is not good laundry practice. A sample of this rotary cooked pulp when examined under the microscope will show marked evidence of fiber degradation. The best run deinking plants show little or no fiber degradation under the microscope.

Rotary Boiler Practice

Old papers treated in rotary boilers can be handled at very high consistencies, and if the temperature is kept below the boiling point—preferably at 180° F., or less—there is a very low steam consumption and almost no staining of the pulp. The rotary should have plenty of spikes in its shell to ensure the old papers being well agitated during the rotation of the rotary boiler. Steam should be introduced from a perforated pipe running throughout the center length of the boiler so that the old papers are uniformly heated. Four to five hours of rotation should be ample. The contents should then be dumped into a pit filled with an agitator. It is good practice to blow off the bulk of the cooking liquor and save this for reuse.

The pit under the rotary should be partly filled with water before dumping the stock in order that the stock can be pumped from the pit. At this stage all of the old paper should be wet and well softened so that vigorous agitation in a fan pump will give complete defibering. Various devices are used for defibering, such as a high pressure pump discharging against a serrated surface, jordans set with wide clearance, breaker beater and circulating tanks with pumps. The most suitable method is a circulating tank and pump.

Circulating Tank Practice

In the circulating tank practice there is provided a steel tank holding from 1000 to 10,000 pounds of

old paper at 3% to 5% consistency. The tank has a cone shaped bottom which feeds into a circulating pump and then discharges into the top of the tank. The cooking chemicals are added to this tank with the old papers, and cooking and defibering proceeds at the same time. In some cases the old papers are first softened in breaker beaters, then dumped to the circulating tank. In other cases the shredded old papers are fed directly to the cooking tank until the correct consistency has been reached.

In the circulating tank practice the cooking temperature is always below the boiling point as the cooking tank is vented to the air. In practice the temperature is seldom allowed to go above 180° F. and in the best practice the temperature is kept below 160° F. Temperatures of 140° to 160° F. can be maintained if the chemicals used are effective in loosening and dissolving the binder of the inks. The circulating pump used must be of the open impeller type to prevent clogging of the pump, especially when the dry paper is fed into the tank. A pump of relatively high efficiency is not suitable for this work as it has poor defibering action. Best defibering is obtained in a pump with wide clearance within the pump casing. It is sometimes possible to machine off parts of the impeller blades and thereby greatly increase defibering action. Any loss in pumping capacity is more than made up by the increased rate at which papers are defibered. The total time in the circulating tank varies from 2 to 5 hours, depending largely on the size of the tank and the circulating pump.

Screening, Thickening, Washing, and Bleaching

The steps of screening, thickening, washing and bleaching follow the cooking and defibering stages. Details of these four steps vary somewhat, but in general the defibered stock at ½% to ¾% consistency is first sent over riffles to remove metal clips and heavy material. It is then sent to screens, preferably of the flat plate type, then to a series of 3 or 4 deckers that washes as it thickens. Dilution occurs after each washing except the last, where bleach solution is added as the thick stock goes to a chest. The amount of bleach solution generally used is so small that there is no need of again washing after bleaching. The pulp is then ready for use in the paper mill.

Cooking Chemicals

Much has been written about the use of cooking chemicals, and there is still a diversity of opinion. Various inks react best to certain chemicals, these being determined by a study of the particular kind of old papers in use. The most common chemicals are soda ash and caustic soda, used either alone or in combination. Many inks contain a percentage of mineral oils which are not saponifiable; therefore a small amount of soap, depending on the hardness of the water, is advisable. In some cases the defibered but unwashed old papers will have a greasy feeling and tend to leave a film along the inside of chests and washers. In cases of this kind, a small amount of soap is well worth trying out. The elimination of this greasy feeling will greatly facilitate the washing action.

For those who wish to study the literature relating to the use of chemicals in deinking processes, it is suggested that special attention be given to an article by Bragg *(2)* in which he presents some interesting experimental data covering a series of mill trials under various conditions, with particular reference to the use of soda ash and caustic soda. This article gives special emphasis to the fact that excessive use of caustic soda is injurious to the fibers and makes washing more difficult.

There is an excessive use of chemicals in some mills in their deinking process. The most common chemical to use is soda ash, and mills vary in its use from 3% to 8%. Some mills prefer caustic soda and its use varies from 2½% to 6%. From long experience it is believed that 3% soda ash is ample. When caustic soda is used alone, not more than 2% should be used. Where papers are hard to deink a combination of 2½% soda ash and ½% caustic soda has proven quite satisfactory.

Economics of Deinking and Handling

It is always dangerous in a paper of this kind to attempt to discuss costs in general terms, as there is so much variation in mill-to-mill operations. Costs are high in some mills due to layout of the plant and to equipment used. A plant carefully laid out to save labor, to do the least amount of pumping, and to use a minimum of steam, can show appreciable savings over many plants now in operation.

The following cost figures are based on January, 1942 prices for a 35-ton per day plant.

Labor per ton of old papers	3.00
Steam per ton of old papers (6000 lb. @ 45c/1000 lb.)	2.75
Power per ton of old papers 100 kw.hr. @ $0.006	0.60
Chemicals per ton of old papers	1.50
Total cost per ton of old papers	7.85
Cost of old magazines per ton del. (*see* Note)	38.71
Overhead	1.00
Total cost before shrinkage	47.56
Shrinkage 25%, yield 75%	
Total cost per ton of deinked pulp allowing for shrinkage	63.50

Note: Feb. 1943 Market—Price $31.50, Brokerage fee (7%) $2.21, Freight $5.00, Total $38.71.

The cost of deinked old paper stock is generally competitive with soda pulp prices, and superior in quality. Deinked old paper stock requires no additional beating. It helps to close a sheet without excessive use of the jordan and, in general, adds bulk to a sheet. A well operated deinking system will produce a paper pulp of good color and with little or no decrease in strength, when compared with the old papers from which it is made.

Conclusions

Proof that the operation of a deinking system is economical from a cost and quality standpoint is evident from the large number of mills now using old paper pulps. The quality of their papers is thoroughly competitive with mills using only virgin pulps. In view, therefore, of the curtailment in pulps, it is suggested that mills faced with a possible pulp shortage give consideration to the use of old paper stock, not only as a war necessity, but also as a national economy now and in normal times.

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Estimation of Carbonyl Groups in Chromic Anhydride Oxystarch and Oxycellulose by Means of Hydroxylamine*

By E. K. Gladding[1] and C. B. Purves[2]

Abstract

The research was designed to account quantitatively for the oxidant consumed in the preparation of oxycelluloses and oxystarches and to learn something concerning the chemical structures of the latter. These objectives required a more accurate determination of the aldehyde and ketone groups in reducing oxycelluloses than those provided by the customary copper number methods. The loss of oxidant caused by the formation of water-soluble degradation products had also to be avoided.

Aqueous hydroxylamine hydrochloride was known to form oximes with reducing sugars,

$$>C{=}O + H_2NOH.HCl \rightarrow >C{=}NOH + H_2O + HCl$$

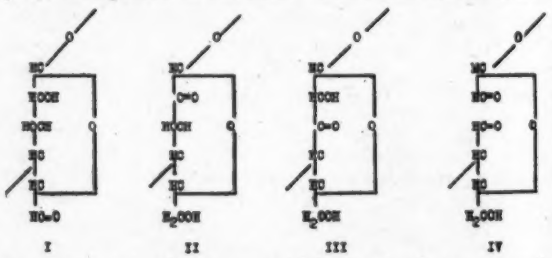
and the course of the reaction was followed by titrating the liberated hydrochloric acid with standard alkali. The highly buffered nature of the system made the method unsuitable for technical oxycelluloses, although massive amounts of carbonyl were estimated with an accuracy of about 5%. Simple sugars condensed in first order reactions that were complete either within 1.5 or within 18 hours at 20°C and the corresponding carbonyl groups were classified as "fast" or "slow." All the aldehyde groups in periodate oxycellulose and oxystarch were of the "fast" type, although the reactions were not first order.

When unswollen linters were oxidized with increasing amounts of chromic anhydride in acetic acid-acetic anhydride at 20°C, up to 28% of the oxidant was accounted for as carboxyl and "fast" carbonyl in the insoluble oxycellulose and water-soluble products were formed even with relatively small amounts of oxidant. Unswollen, powdered starch was not appreciably affected in the same conditions. When highly swollen linters were used, duplicate oxidations proceeded very much more rapidly and caused no perceptible production of water-soluble material until an oxidation level of about 0.3 atoms of oxygen per glucose unit was reached. About 75% of the oxidant consumed below this level was represented by the insoluble oxycellulose but the recovery fell sharply thereafter. The fate of the remaining 25% was not determined although it may have produced "slow" carbonyl groups in the oxycellulose.

These results show that the chemical course of oxidations that are unaccompanied by substantial swelling may be dominated by the extent of colloidal surface present in the original cellulose or starch. The colloidal condition of the latter, however, was not nearly so critical when the chromic anhydride was dissolved in 0.2N *aqueous sulphuric acid, probably because aqueous solutions exert a powerful swelling action.*

A previous article (14) suggested that the macromolecules of oxycelluloses and oxystarches contain glucose residues oxidized as in Formulas I to IV, together with other residues bearing carbonyls at more than one position in their structure or containing carboxylic acid groups. Sodium periodate in certain circumstances gave an almost quantitative yield of IV, which was estimated in a satisfactory way by taking advantage of the half-acetal glyoxal residue it contained. The present work originated in attempts to differentiate between, and to estimate the carbonyl groups in, I, II and III because these structures may well be the principal initial products formed by oxidants of technical importance.

Although the estimation of the reduction of solutions of copper sulphate *(5, 8)*, potassium ferricyanide *(13)*, silver nitrate *(15)*, or ceric sulphate *(12)* by oxycellulose or oxystarch is very valuable for diagnostic and control purposes, the data give only a qualitative, or at most a semiquantitative, measure of the carbonyl groups that the oxidized polysaccharides contain. Perhaps the most promising quantitative determination was that proposed by Harris and his collaborators *(18, 21)*, who oxidized the aldehyde groups of periodate oxycellulose IV to carboxylic acid by means of standard hypoiodite solution. Their modification of Cajori's original procedure *(6)* may eventually be found to differentiate aldehyde from the less easily oxidized ketonic groups *(24)* exemplified in formulas II and III. If a method



I II III IV

for determining ketone, or aldehyde *plus* ketone (total carbonyl) could be developed it would be possible to follow the oxidations in a quantitative way because estimations for carboxylic acid, the other probable stage of oxidation, are now on a fairly satisfactory basis *(11, 17, 22, 23, 25)*. The resulting ability to strike a balance between oxidant consumed and oxidation produced would do much to place the study of oxycelluloses and oxystarches upon a secure and fruitful basis.

The first attempts made in this laboratory to estimate total carbonyl were based upon the cyanhydrin reaction:

$$=C{=}O + NaCN \rightarrow =C(OH)COONa + NH_3\uparrow,$$

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[1] Research Associate, Massachusetts Institute of Technology, Cambridge, Mass. (1941-1942).

[2] Member TAPPI; Associate Professor of Organic Chemistry, Massachusetts Institute of Technology, Cambridge, Mass.

the progress of which was followed by titration of the unused excess of cyanide *(3)* or of the ammonia expelled by a steam distillation *(10)*. Although the results with glucose, fructose, and other simple sugars were satisfactory, the extreme sensitivity of oxycelluloses to the slight alkalinity *(2, 7, 9)* required by the cyanhydrin reaction rendered the estimation uncertain. In an endeavor to avoid this difficulty, attention was directed to the condensation of the carbonyl groups with hydroxylamine hydrochloride:

$$=C=O + H_2NOH.HCl \rightarrow =C=NOH + HCl;$$

because, in many simple cases, this reaction was known to proceed almost to completion at pH 4-5, or on the acid side of neutrality. Bryant and Smith *(4)*, who reviewed the literature, were able to estimate the carbonyl group in glucose by overcoming the difficulties connected with titrating the hydrochloric acid liberated in the highly buffered solution. The present article describes three modifications of their technique, the first of which was designed to estimate the large amounts of carbonyl present in reducing sugars and in polysaccharides oxidized with periodate. The second modification was convenient for following the course of the reaction and the third for determining the smaller amounts of carbonyl present in various oxycelluloses. Finally, the method was tested in a study of cellulose oxidized with various amounts of chromic anhydride dissolved in acetic acid-acetic anhydride or aqueous sulphuric acid. This study paid special attention to the effect of a previous swelling of the cellulose upon the course of the oxidation and to the efficiency with which the oxidant was utilized. The requisite estimations of acidic groups were carried out by Yackell and Kenyon's calcium acetate method *(25)* in which the acetic acid liberated in the reaction:

$$Ca(OAc)_2 + 2RCOOH \rightarrow Ca(OOCR)_2 + 2HOAc$$

is titrated with standard alkali.

Estimation of Carbonyl Groups

Baker's C.P. analyzed grade of hydroxylamine hydrochloride was suitable but other samples, either older or of less purity, had to be recrystallized by cooling the hot, very concentrated, aqueous solution. Impure samples gave erratic results.

The indicator used for the titration of the liberated hydrochloric acid was six drops of a standard 0.1% solution of bromphenol blue in alcohol (pH 2.8-4.6). Hydroxylamine hydrochloride solutions were made up as needed because they were not quite stable.

Method A. The reagent was prepared by dissolving 10 grams of pure hydroxylamine hydrochloride in water, adjusting the pH of the solution to about 5 with 48 ml. of 0.5*N* sodium hydroxide and by making the volume up to 200 ml. with water. Aliquots of 50 ml. were pipetted accurately into 125-ml. glass-stoppered Erlenmeyer flasks containing weighed samples of the reducing sugar, oxycellulose, or oxystarch. These sample weights were chosen so that not more than 60% (0.0036 mol) of the available free hydroxylamine was utilized, because the consumption of a larger percentage rendered the final pH of the solution less than 3.5 and the formation of the oxime remained incomplete. The flasks, plus a similar one containing a blank, were kept at room temperature for 1.5 hours in the case of "fast" carbonyls (*see* below) and for 14-18 hours with "slow" ones. Bromphenol blue was then added and the solutions were titrated to the neutral point of the indicator with 0.5*N* hydrochloric acid. Although the solution was highly buffered, the conditions chosen kept the titration error to about 0.1 ml. in an average titration of 6.5 ml.

If x was the sample weight in grams, and y the difference in titer between experiment and blank in milliliters of normal acid, the carbonyl content in moles per gram was given by $y/1000x$.

Method B. Hydroxylamine, hydrochloride, 2.5 grams, was dissolved in 40 ml. of water, bromphenol blue indicator was added and the solution was brought to the neutral point (pH 3.5) with a few drops of 0.5*N* NaOH. At zero time, this solution was used to dissolve the sugar sample, whose weight was chosen as in Method A and which was contained in a dry flask. Thereafter, the mixture was momentarily allowed to become acid before it was quickly neutralized with 0.5*N* alkali added from a buret. The total amount of NaOH used after definite intervals of time was noted.

Method C. Each 200 ml. of the hydroxylamine reagent solution contained 10 grams of the pure hydrochloride and not more than 40 ml. of 0.5*N* sodium hydroxide. The sample of oxystarch or oxycellulose, 1.0 to 1.5 grams as a rule, was chosen to contain not more than 0.0015 moles of carbonyl, corresponding to a utilization of 30% of the free hydroxylamine available in 60 ml. of the reagent. This volume was pipetted into the glass-stoppered Erlenmeyer flasks containing the samples, and the mixtures were kept at room temperature for 1.5 hours. Reagent blanks and blanks containing unoxidized cellulose were run. After 1.5 hours, the mixtures were filtered through separate dry Buchner funnels, and 50-ml. aliquots of the filtrates were titrated with 0.1*N* hydrochloric acid. Since the end point to bromphenol blue was insensitive to less than 0.5 ml. of this acid, the titrations were carried out electrometrically to pH 3.2 with a Beckman pH meter (laboratory model G). Duplicates then checked to 0.1 ml. and usually to 0.05 ml.

This estimation gave the sum of the carbonyl and carboxyl groups when the samples were acidic. In such cases, the 1.0 to 1.5-gram samples and 60 ml. of 0.5*N* aqueous calcium acetate were kept together in a glass-stoppered Erlenmeyer flask for 1.5 hours at room temperature. A dry funnel and flask were used in filtering the mixture, and a 50-ml. aliquot of the filtrate was titrated to a phenolphthalein end point with 0.1*N* sodium hydroxide. The titration, when corrected for the small amount of acid or base used in a calcium acetate blank, corresponded to five sixths of the carboxylic acid content of the sample *(25)*. Duplicate titrations agreed to 0.1 ml. in a total consumption of 2 to 5 ml. The calcium salt of the sample, retained quantitatively on the Buchner funnel, was thoroughly washed with distilled water before it was submitted to the carbonyl estimation (Method C) which then measured carbonyl groups alone.

The results for the estimation of carboxyl, as well as for the carbonyl methods B and C, were calculated as described for method A.

Preparation of Chromic Anhydride Oxycelluloses

Swelling of Cellulose. High-grade cotton linters, for which we are indebted to H. M. Spurlin and the Hercules Powder Company, were dewaxed by thorough extraction with hot alcohol-benzene (1 vol.: 2 vol.) The air-dry product, 21.25 grams, was swollen by immersion in a solution of 80 grams of NaOH in 720 ml. of water previously chilled to 3°C.

(20). After keeping the mixture at this temperature for 2.5 hours, it was diluted with 1 liter of prechilled 10% acetic acid, and 15 minutes later the cellulose was filtered from the slightly acidic solution. The wet mass of cellulose was never permitted to dry between the following operations, which consisted in 30 minutes' immersion in a second liter of dilute acetic acid, filtration, and very thorough washing with distilled water. The product was preserved under water.

Although some collapse of the wet swollen cellulose was unavoidable during drying, the following procedure left a colloidal surface large enough to include 15-20% of the entire material *(1)*. The wet preparation was immersed, each time for 15 minutes, in four 300-ml. volumes of anhydrous methanol and was then given four similar treatments in sodium-dried, thiophene-free benzene. Care was taken to avoid any drying during the transfers, and the benzene was finally evaporated at room temperature in the vacuum of an oil pump protected by a large dry-ice trap. The product was stored over phosphorus pentoxide in an evacuated desiccator. The loss in weight caused by swelling and drying was 6.0, 5.9, and 6.0% in three experiments, and about half this loss represented the moisture content of the original cellulose. Water-wet, swollen samples destined for oxidation in acetic acid were immersed, 20 grams dry weight, in 500 ml. of the 50% acid and then in 300-ml. volumes of the glacial acid. This treatment did not seem to cause much decrease in the degree of swelling.

Oxidations with Chromic Anhydride. The air-dry linters, 21.25 grams, were swollen and solvent exchanged by one of the procedures given above. This weight corresponded to 20.0 grams solvent-dried cellulose. One liter of oxidizing solution was used for this amount in all cases and contained 0.832 gram (0.1 atom of oxygen per glucose residue) of chromic anhydride or a multiple thereof. The solvent was a mixture of glacial acetic acid-acetic anhydride (4:1) or 0.2*N* aqueous sulphuric acid, and the concentration of oxidant was checked by the iodometric titration of small aliquots. Blank experiments showed that the oxidizing power of the acetic acid reagent decreased very slowly on standing and that the sulfuric acid reagent was stable. These solutions were added at 10° C. to the swollen cellulose (either wet with the proper solvent or dried as above) and the mixtures were promptly put in a room maintained at 20° C. The course of the oxidation was followed by tests with lead acetate solution for the chromate ion. Reduction of the chromate was complete in 1 day in the acetic acid oxidations and in 10-12 days in the sulphuric acid ones.

After recovery, the products were soaked for 2.5 hours in 10% acetic acid to remove as much as possible of the adsorbed chromium salts. They were then washed in much distilled water, dried through alcohol and benzene, and stored over phosphorus pentoxide in an evacuated desiccator. In a typical experiment, 1.644 grams of chromic anhydride (mol. wt. = 100) provided 1.644/100×3/2 or 0.02465 atoms of oxygen, corresponding to 0.02465×162/20 or 0.200 atoms per glucose unit in the 20-gram cellulose sample. The 19.68 grams of oxycellulose recovered had consumed therefore 0.02465/19.68 or 0.00125 atoms of oxygen per gram.

Oxycelluloses prepared with 0.4 oxygen atoms per glucose unit or less were fibrous, but more highly oxidized samples were nearly powders. All had an extremely light blue tinge that was attributed to traces of tri-valent chromium which are reported to be very difficult to remove *(9)*.

Samples oxidized in sulphuric acid solution with 0.1, 0.3, 0.5, and 0.6 atoms of oxygen per glucose unit contained 0.0, 0.09, 0.30, and 0.35%, respectively, of ash. One sample oxidized in acetic acid with 0.2 atoms had an ash content of 0.33%.

Exactly similar oxidations were carried out with unswollen but dewaxed linters and with Merck's powdered potato starch, allowance being made for the 3.9% of moisture in the linters and the 14.6% in the starch.

Results and Discussion

The reliability of the hydroxylamine estimation (Method A) for carbonyl was first investigated by means of the sugars listed in Table I and the results ranged from 95 to 103% of theory. It was necessary, however, to use reaction times varying from 1.5 to 18 hours to secure nearly quantitative results with different sugars. The rates at which the latter reacted with excess hydroxylamine were then followed by Method B. When the logarithm of the sugar left uncondensed at any time was plotted against the elapsed time (Fig. 1), linear plots characteristic of first order reactions with respect to the sugars were obtained. These plots had slopes that could be classified into two broad groups, the first of which pertained to sugars that reacted completely within 1.5 hours, while sugars corresponding to the second group required the longer time. If the assumption be made that condensation occurred only with the open-chain, aldehydo modifications of the aldoses, the data suggest that the pyranose ⇄ furanose ⇄ aldehydo equilibria were much more labile in xylose, mannose, and galactose than in cellobiose, lactose, and glucose. The sluggish behavior of fructose, in which conversion to the open-chain form is particularly easy, may be attributed to the fact that fructose is a keto and not an aldo sugar.

TABLE I.—DETERMINATION OF THE CARBONYL CONTENT OF SUGARS WITH HYDROXYLAMINE

Sugar	Grams of sugar taken	Mols of carbonyl taken	Mols of carbonyl found	Per cent carbonyl found
"Fast" carbonyls, time of reaction = 1.5 hours				
mannose	0.611	0.00340	0.00342	100
mannose	0.611	0.00340	0.00338	99
galactose	0.618	0.00343	0.00340	99
galactose	0.610	0.00338	0.00329	98
galactose	0.620	0.00344	0.00332	97
xylose	0.611	0.00407	0.00404	99
xylose	0.559	0.00372	0.00362	98
arabinose	0.512	0.00341	0.00327	96
arabinose	0.514	0.00342	0.00321	95
"Slow" carbonyls, time of reaction = 10-18 hours				
glucose	0.495	0.00275	0.00279	100
fructose	0.613	0.00340	0.00350	103
fructose	0.613	0.00340	0.00321	95
fructose	0.613	0.00340	0.00318	94
lactose	1.206	0.00352	0.00350	100
cellobiose	1.157	0.00338	0.00319	94
cellobiose	1.132	0.00332	0.00314	95

Table II contains data on starch and cellulose oxidized with known amounts of periodate (Column 2) to products in which the glycol unit in the second and third positions of the glucose residues was replaced by two aldehyde groups *(16, 21)*. Analysis of these products by the glyoxal tetramethyl acetal method *(14)* (Column 5) and for carbonyl groups by hydroxylamine (Columns 3 and 4) gave results that differed by not more than 7%. This agreement was considered satisfactory because the former values may be four or five % high. Another check upon the validity of the hydroxylamine titration was found in the satisfactory nitrogen analyses of the dioximes of the periodate oxycelluloses (Table II).

TABLE II.—CARBONYL CONTENT OF PERIODATE OXYSTARCH AND OXYCELLULOSE

Sample number	Mols of oxidant consumed per gram	Mols of carbonyl found per gram	Per cent of oxidant as C = O (a)	Per cent of oxidant found by glyoxal analysis (b)
Oxystarch:				
8-1	0.00532	0.0101	95	96
Oxycellulose:				
49-1	0.00234	0.00440	94	98
62-2	0.00442	0.00823	93	98(c)
62-2	0.00442	0.00823	93	98
62-2	0.00442	0.00804	91	98
37-1	0.00470	0.00892	95	..(d)
37-1	0.00470	0.00864	92	..

(a) Based on reaction: 1 atom O → 2 mols C = O.
(b) See reference *(14)*.
(c) Nitrogen content of oxime: Calculated N = 10.6%; Found N = 10.4, 10.6%
(d) Nitrogen content of oxime: Calculated N = 11.5%; Found N = 11.2, 11.8%

The nonlinearity of the logarithmic rate plots (Fig. 2) showed that two different types of carbonyl reacted, although both were in the "fast" category. These types doubtless corresponded to the aldehyde groups in the second and third positions of the oxycellulose; the former being half the glyoxal residue and the latter being the reducing portion of an erythrose unit. (Formula IV).

Chromic anhydride oxycelluloses were examined by the hydroxylamine Method C and an initial rapid reaction, which was complete in 1.5 to 2 hours, was followed by a slow one (Fig. 3). Although "slow" carbonyl groups were possibly responsible for this secondary reaction, the point was not proved, because the decrease in titer of the hydroxylamine blanks proceeded at approximately the same rate. Unoxidized, swollen cellulose, however, appeared to be an anticatalyst for the later stages of the decomposition of the reagent, and this variable effect made the proper blanks for oxycellulose experiments uncertain. This difficulty was not apparent when the reaction time was limited to 1.5 hours, as is shown by comparison between the following pairs of reagent and unoxidized cellulose blanks: 45.8, 45.7; 44.15, 44.15; 45.3, 45.3; 44.25, 44.3; 43.1, 43.0 ml. of 0.1*N* hydrochloric acid. These data also show that the swollen unoxidized cellulose contained a negligible number of carbonyl groups. A reaction time of 1.5 hours was adopted in subsequent experiments, because the results could be interpreted definitely in terms of the carbonyl groups.

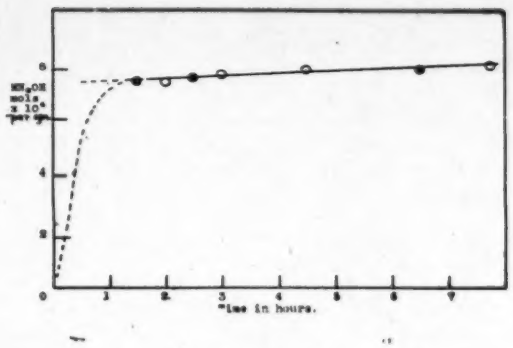

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FIG. 3
Rate of Reaction of Hydroxylamine with Chromic Anhydride Oxycellulose

The use of chromic anhydride in acid solution naturally produced oxycelluloses containing free carboxylic acid groups that bound additional quantities of hydroxylamine as a salt during the carbonyl estimation. Correct carbonyl values were readily obtained by using the neutral calcium salt of the oxycellulose, which was incidentally prepared when determining the carboxylic acid content by the calcium acetate method *(25)*. The data in Table III show that the sum (Column 4) of the carboxyl (Column 2) and the carbonyl groups (Column 3) was always within 4% of the total hydroxylamine combined by the acidic form of the oxycellulose (Column 5). Hy-

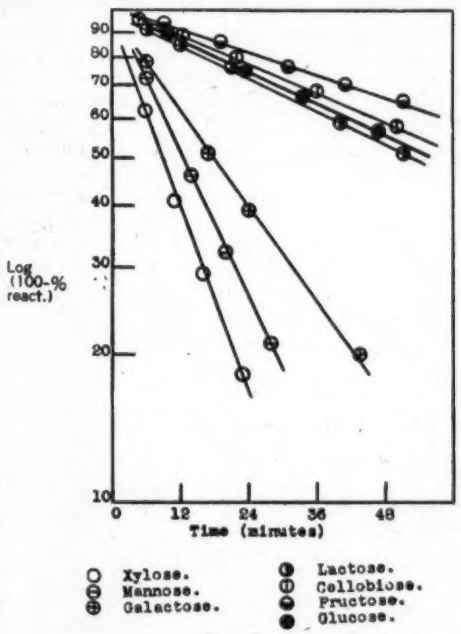

FIG. 1
Rates of Reaction: Sugars with Hydroxylamine

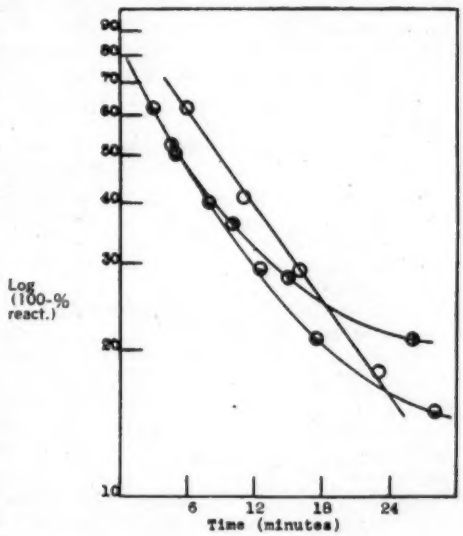

FIG. 2
Rates of Reaction: Periodate Oxystarch and Periodate Oxycellulose with Hydroxylamine

TABLE III.—RELATION OF TOTAL HYDROXYLAMINE CONSUMED TO THE CARBOXYL AND CARBONYL CONTENTS OF OXYCELLULOSES; REPRODUCIBILITY OF RESULTS

Atoms of oxygen consumed per mol of cellulose (a)	Mols of carboxyl per mol found (b)	Mols of C = O per mol found by analysis of Ca salt (c)	Sum of carboxyl plus carbonyl (d)	Total NH_2OH consumed per mol (c)
Chromic anhydride oxycellulose, oxidized in HOAc-Ac_2O:				
0.195	0.0316	0.0720	0.104	0.111
0.195	0.0316	0.0722	0.104	0.111
0.195	0.0332	0.0740	0.107	0.107
0.202	0.0343	0.0779	0.112	0.115
0.202	0.0344	0.0805	0.115	0.114
0.202	0.0340	0.0787	0.113	0.109
0.202	0.0321	.....	....	0.109
0.300	0.0538	0.110	0.164	0.170
0.380	0.0674	0.119	0.186	0.192
0.476	0.0805	0.132	0.212	0.214
Chromic anhydride oxycellulose, oxidized in aqueous H_2SO_4:				
0.200	0.035	0.071	0.106	0.106
0.200	.....	.....	....	0.104
0.300	0.0485	0.075	0.123	0.128
0.300	0.0485	0.075	0.123	0.128

(a) During the oxidation.
(b) Calcium acetate titration, see reference *(25)*.
(c) With hydroxylamine, Method C.
(d) Sum of (b) plus (c).

droxylammonium salt formation was therefore practically quantitative, and thus interposed no difficulty in the carbonyl estimation. The duplicate data in Table III also show the degree of accuracy attained in routine analyses.

The carbonyl and carboxyl contents of four series of oxycelluloses (Table IV) are plotted in Figs. 4 and 5 against the amount of oxidant used in their preparation. It is evident that the efficiency of the acetic acid oxidant in producing carbonyls in swollen cellulose decreased when the equivalent of 0.2 to 0.3 atom of oxygen per glucose unit had been utilized. Since the cellulose was swollen so that about one fifth of its mass was immediately available to the oxidant, it is plausible to argue that the initial stage of the oxidation occurred at the colloidal surface of the cellulose. This primary oxidation was followed by secondary ones leading to a further slight increase in the carbonyl value. The use of aqueous sulphuric acid as a solvent for the chromic anhydride led to smaller values throughout, partly because the rate of oxidation was at least ten times slower than in acetic acid and secondary oxidation and hydrolysis to acidic groups and water-soluble products had more time to become important. As in the previous case, the in-

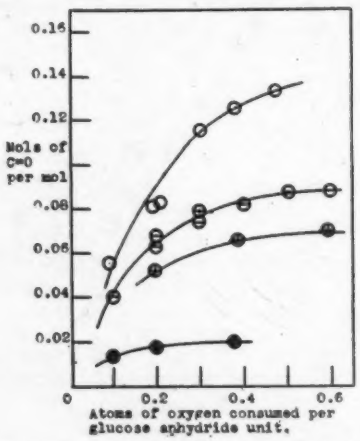

FIG. 4
Mols of Carbonyl per Mol as a Function of the Extent of Oxidation

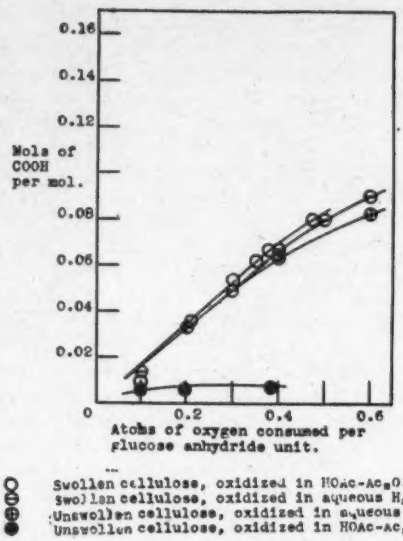

FIG. 5
Mols of Carboxyl per Mol as a Function of the Extent of Oxidation

crease in carbonyl became less when about 0.3 atom of oxygen per glucose unit had been utilized. When unswollen linters were used, the exhaustion of the much smaller colloidal surface by the acetic acid oxidant was complete at less than 0.1 atom of oxidation and the total amount of carbonyl introduced was less than one-sixth of that observed with swollen samples. These differences were not nearly so spectacular with the 0.2*N* aqueous sulphuric acid oxidant; doubtless because the swelling of the unswollen samples in this reagent was rapid and extensive. Figure 5 shows that the production of carboxylic acid groups was also greatly affected by the condition of the cellulose when the oxidant was in acetic acid but not when in aqueous sulphuric acid solution. The same explanation is consistent with these observations.

Starch, when oxidized with chromic anhydride in

TABLE IV.—CARBONYL AND CARBOXYL CONTENTS OF CHROMIC ANHYDRIDE OXYCELLULOSE

Temperature of Oxidation = 20°

Atoms of oxygen consumed per mol cellulose	Mols of carboxyl per mol of oxy-cellulose	Mols of carbonyl per mol of oxy-cellulose	% of oxidant as COOH (a)	% of oxidant as C=O (b)	% of oxidant found in oxycell.
Swollen cellulose, oxidized in aqueous H_2SO_4:					
0.100(c)	0.014	0.040	28	40	68
0.100	0.014	0.040	28	40	68
0.200	0.035	0.068	35	34	69
0.200	0.034	0.062	34	31	65
0.200	0.034	0.063	34	31	65
0.300	0.052	0.074	34	24	58
0.300(c)	0.049	0.079	32	26	58
0.300	0.049	0.080	32	26	58
0.400	0.067	0.082	33	20	53
0.500	0.080	0.088	31	17	48
0.600	0.090	0.088	28	14	42
Unswollen cellulose, oxidized in aqueous H_2SO_4:					
0.195	0.035	0.052	36	27	63
0.392	0.063	0.066	32	17	49
0.587(c)	0.082	0.071	27	12	39
0.587	0.082	0.071	27	12	39
Swollen cellulose, oxidized in HOAc-Ac_2O:					
0.106	0.011	0.055	21	53	74
0.195	0.033	0.080	33	40	73
0.195	0.032	0.080	32	40	72
0.202	0.034	0.080	34	40	74
0.202	0.034	0.081	34	41	75
0.210	0.036	0.083	34	40	74
0.300	0.054	0.116	36	38	74
0.350	0.062	....	35	..	..
0.380	0.067	0.126	35	33	68
0.476	0.080	0.134	34	28	62
Unswollen cellulose, oxidized in HOAc-Ac_2O:					
0.0991	0.006	0.016	11	16.5	27.5
0.198	0.006	0.018	6	9	15
0.386	0.007	0.019	3.4	4.9	8.3

(a) Calculated on the basis: 2 atom O → 1 COOH
(b) Calculated on the basis: 1 atom O → 1 C=O
(c) Oxidized at 25°.

0.2*M* sulphuric acid at 20°C. to the equivalent of 0.300 atoms of oxygen, gave an oxystarch containing 0.081 and 0.0585 moles, respectively, of carbonyl and carboxyl groups. Since the corresponding figures for swollen cellulose were 0.075 and 0.0495 moles, the behavior of the starch was in no way abnormal. The failure of starch to be oxidized at all by the chromic anhydride-acetic acid-acetic anhydride mixture was accordingly unexpected and was attributed to the failure of the reagents to penetrate beyond the minute surface of the powdered but unswollen starch granule.

Figure 6 summarizes an attempt to account for the oxidant used in the various runs, and is based on the assumption that the conversion of an alcohol to a carbonyl and a carboxyl group requires one and two atoms of oxygen, respectively. This assumption is true for primary alcohols, [Formula I] but the oxidation of the 2,3 glycol unit in cellulose [Formulas II, III and IV] to two acidic groups requires only three atoms. Since no allowance could be made for the latter eventuality, the percentages of oxidant accounted for as carbonyl and carboxyl groups in the insoluble oxycelluloses are maximum ones. These percentages, indicated by the solid lines in Fig. 6, decreased for swollen cellulose after 0.2-0.3 atoms of oxygen had been used, or about the stage when the primary oxidation of the colloidal surfaces was thought to be complete. The same stage signalized the beginning of the observed decrease in the yield of the oxycelluloses from 100% of the weight of the linters taken, as secondary oxidation began to form water-soluble products (Fig. 6, upper broken line). Comparisons made between these decreases for the celluloses highly oxidized in acetic acid showed that a 1% decrease in yield corresponded to the utilization of only 2-4% of the oxidant. It followed that the loss of the latter by any undetected loss of oxycellulose in the milder oxidations could not have exceeded a few per cent. The general conclusion was that substantially all of the oxidant up to 0.3 atoms of oxygen per glucose unit was represented by the oxycellulose, but that not more than 75% was accounted for as carbonyl and carboxyl groups.

Although it is premature to speculate on the fate of the missing 25%, it may be pointed out that the hydroxylamine estimation used was capable of determining completely only the "fast" carbonyls and that any of a ketonic nature, as in fructose, would be but partly estimated. Another possible explanation may be that some of the carbonyls condense with conveniently located hydroxyl groups to give non-reducing cyclic products of the acetal type recovered in certain circumstances from periodate oxystarch *(14, 19)*. In view of these uncertainties it is possible that all of the various kinds of carbonyl groups that may be present in oxycelluloses and oxystarches are not completely estimated by the present hydroxylamine method.

As might be expected, the oxidation of the unswollen linters in the acetic acid reagent consisted of a primary reaction, too small to be detected by the present technique, and a secondary oxidation leading to the recovery of only 99% of insoluble oxycellulose at an oxidation level as low as 0.1 atom per glucose unit (Fig. 6, lower broken line). The corresponding recovery of oxidant was only 28% (lowest full line). These striking differences in the course of the oxidation of swollen and unswollen linters make it reasonable to assume that similar differences will occur in other oxidations, such as those produced by ozone or light on solid cellulose, in which penetration of the crystallites and swelling are inconsiderable. It is also reasonable to conclude that the initial steps in oxidations of this type will be studied most conveniently with highly swollen samples at an oxidation level not exceeding 0.2 atoms of oxygen per glucose unit. When the oxidant is also a swelling agent, like chromic anhydride in aqueous sulphuric acid, preswelling of the cellulose seems hardly worth while. (Fig. 6).

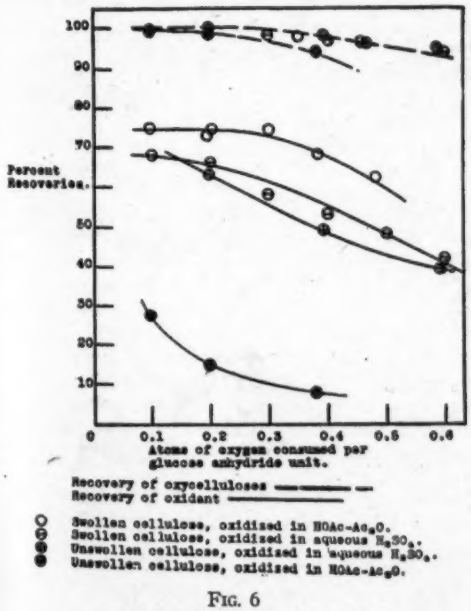

FIG. 6
Oxidation with Chromic Anhydride

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The Effects of Various Cooking Conditions on the Bleachability and Strength Characteristics of Kraft Pulp*

By Edward H. Hill[1]

Abstract

Laboratory and mill alkaline cooks were made by varying the time, pressure, chemical concentration, and volume of liquor. The laboratory digester held about 30 pounds of moisture-free chips, and the mill digester about 36,000 pounds of moisture-free chips. Pulps were produced with permanganate numbers ranging from 31.4 to 13.4. The pulps used for bleaching had permanganate numbers from 28.6 to 13.4 and the yield of moisture-free pulp ran from 51.4% to 47.8% air-dry pulp based on moisture-free wood. To bleach these pulps to a G. E. brightness around 80.0% by a six multistage method required from 11.5% to 4.1% chlorine. The best strength values were shown by the pulps having permanganate numbers around 14.0 to 18.0 which required from 6.8% to 4.1% chlorine to bleach to a brightness around 80.0%. The best strength characteristics for unbleached pulps were obtained by cooking at 115 p.s.i. and a liquor volume of 24 gallons per hundred pounds of moisture-free chips.

The object of this paper is to present the data accumulated from an investigation made for the purpose of determining the effects of various cooking conditions on the strength and bleachability of kraft pulps. It is a known fact that the equipment, the species of woods, and the sulphidity of the liquor play an important part in the quality of pulp produced. It is also known in the industry that the same species of wood will cook differently in different localities. It is hoped that this paper will stimulate a discussion so that data gathered in other localities will be presented by those present. On the other hand it is believed that the data in this report can be used as a guide for making a study to determine the correct method of cooking necessary to obtain the best quality pulp under certain conditions.

Four series of cooks are reported: two sets for bleached kraft pulp and two for brown kraft pulp. The cooks for bleaching purposes were made in the experimental laboratory digester, and those made for brown kraft pulp were made in the mill digester. Following is a list of the variables used in making these cooks.

Series 1. Laboratory Cooks. Varying the liquor concentration, all other factors constant.
Series 2. Laboratory Cooks. Varying the cooking time, all other factors constant.
Series 3. Mill Cooks. Varying the cooking time, all other factors constant.
Series 4. Mill Cooks. Varying the volume of liquor, all other factors constant.

The laboratory cooks were made in a small digester with the capacity of about 30 pounds of moisture-free chips. The digester was equipped with a circulating pump and could be cooked with either direct or indirect steam. This digester is also equipped with a blow tank, and when it was constructed it was hoped that it would be possible to duplicate the exact mill conditions. However, it has been found that the strength characteristics of the pulp cooked in the laboratory digester are, in most cases, higher than those of the pulp cooked in the mill digesters. In charging the laboratory digester the chips were added and then the white and black liquor. The circulating pump was run during the entire cook. The cooking time was determined from the time the steam was turned on the digester to the time the contents of the digester started to blow into the blow tank. In designing this digester, the height, diameter, cyclone, relief line, size of circulating system, blow tank, etc. of the mill digesters were duplicated on a miniature scale. Direct steam was used in cooking the pulp in both the laboratory and mill digesters.

The mill cooks were made in a digester with a capacity of 3140 cubic feet. The digester was equipped with a circulating pump but this was not used in making these cooks. The digester was first filled with chips and then the measured amounts of white and black liquor were added. The relief was used considerably in bringing the digester up to pressure, and just before blowing. As far as possible the same relief conditions were used in cooking the laboratory pulps.

The permanganate numbers were made by the standard TAPPI T 214 m-37 method. The only variable was that a clothes wringer was used to press a small disk of wet pulp to a certain consistency so that the right amount could be weighed for a one-gram sample.

The beatings were made in a beater under the conditions specified in the TAPPI Standard T 201 m-37. The finishing and testing of the sheets were made by TAPPI Standard T 205 m-40, using the standard British sheet mold. The handsheets were conditioned at 65% R. H., and 70° F. for 24 hours. The results presented in this report are obtained by dividing the average burst tests by the basis weight and multiplying the answer by ten. The tear is obtained by the total gram tear from 16 sheets; dividing the answer by the basis weight and multiplying the answer by 100.

The bleaching was done in glass carboys at a consistency of 3% under the following conditions:

1. Chlorination Stage: Time: 60 minutes. Temperature: 77° F.
2. Caustic Stage: Time: 90 minutes. Temperature: 120° F.
3. Hypochlorite Stage: Time: 90 minutes. Temperature: 105° F.
5. Hypochlorite Stage: Time: 60 minutes. Temperature: 110° F.
6. Hypochlorite Stage: Time: 180 minutes. Temperature: 100° F.

4. Caustic Stage: Time: 90 minutes. Temperature: 120° F.

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[1] Member TAPPI; Technical Director, North Carolina Pulp Co., Plymouth, N. C.

The wood used for these cooks was the regular mill wood chipped under mill conditions. The chips used in the laboratory cooks were all taken from the chip bins at one time, weighed and wrapped in waterproof paper until needed. Mechanical separation of these chips showed 8.4% over one inch size, 84.3% over one-half inch size, 6.4% over one-fourth inch size, and 0.9% under one-fourth inch size.

The white and black liquor used was the regular mill liquor. Enough liquor was set aside for the laboratory cooks. This is the reason the tests on this liquor were so uniform.

The usual tests on the white liquor will run about 0.12 pounds per gallon of sodium carbonate; 0.23 pounds per gallon of sodium sulphide and 0.68 pounds per gallon of sodium hydroxide. The liquor figures are expressed in terms of sodium oxide. The causticity usually runs around 85.0% and the sulphidity about 25.0%.

The chlorine and caustic used in the bleaching experiments were taken from the usual mill supply. All the bleaching figures are expressed in terms of chlorine.

The following tables give the cooking, bleaching, and strength characteristics of the different pulps made from this report.

TABLE I.—SERIES 1. VARYING THE LIQUOR CONCENTRATION, ALL OTHER FACTORS CONSTANT

Cook Numbers	E 1-2	E 3-4	E 5-6	E 8-9	E 10-11
Moisture in Chips, %	48.0	48.0	48.0	48.0	48.0
Total Alkali on Moisture-free Wood, %	24.0	26.0	28.0	30.0	32.0
Causticity of Liquor, %	82.0	82.0	82.0	82.0	82.0
Sulphidity of Liquor, %	26.0	26.0	26.0	26.0	26.0
Liquor per 100 lb. Moisture-free Wood, gal.	40	40	40	40	40
Cooking time, hours	4.0	4.0	4.0	4.0	4.0
Temperature (max.), ° F.	350	350	350	350	350
Pressure, p.s.i.	115	115	115	115	115
To temperature, hours	1½	1½	1½	1½	1½
Air-dry Yield on Moisture-free Wood, %	51.4	50.8	49.4	48.6	47.8
Air-dry Screenings on Moisture-free Wood, %	2.6	2.0	1.3	0.9	0.2
Causticity of Spent Liquor, %	10.5	10.4	12.6	16.8	21.8
Na_2CO_3 of Spent Liquor, g./l.	46.5	49.2	53.4	58.4	60.3
Permanganate No. (TAPPI)	28.6	24.0	21.6	18.4	13.4
Brightness (unbleached), %	19.6	22.0	24.6	27.4	26.8

Note: Total alkali expressed in terms of sodium carbonate.

BLEACHING DATA

Chlorine used 1st stage	7.4	5.7	5.1	4.3	2.6
pH End of 1st Stage	1.8	1.9	1.9	2.0	2.2
Causticity used 2nd stage, %	1½	1½	1½	1½	1½
pH End of 2nd stage	9.6	9.8	9.8	10.1	10.4
Chlorine (Hypo) used 3rd stage, %	2.0	1.6	1.4	1.1	0.9
pH End of 3rd stage	8.4	8.4	8.2	8.5	8.6
Caustic used 4th stage, %	0.5	0.5	0.5	0.5	0.5
pH End of 4th stage	10.8	10.9	10.8	10.8	10.9
Chlorine (Hypo) used 5th stage, %	1.5	1.3	0.9	0.8	0.4
pH End of 5th stage	8.2	8.3	8.3	8.4	8.3
Chlorine (Hypo) used 6th stage, %	0.6	0.6	0.4	0.6	0.2
pH End of 6th stage	8.5	8.4	8.4	8.5	8.4
Total Chlorine used, %	11.5	9.2	7.8	6.8	4.1
Brightness (G.E.), %	82.0	81.3	82.3	80.4	81.8

STRENGTH (Tear)

Cook Numbers	E 1-2	E 3-4	E 5-6	E 8-9	E 10-11
Beating time, minutes					
5	280	290	284	310	300
25	264	253	240	296	285
45	230	210	200	284	240
65	200	190	164	265	210
75	180	178	158	268	168
85	164	146	146	246	154
95	150	140	136	210	146

BURST (Mullen)

Beating time, minutes					
5	58	60	64	90	82
25	120	134	140	170	160
45	146	148	148	164	148
65	158	146	156	164	146
75	146	140	142	158	136
85	138	136	140	152	130
95	130	132	138	158	132
Tear value	494	463	440	580	525
Burst value	266	282	288	334	308
Pulp value	760	745	728	914	833

TABLE II.—SERIES 2. VARYING COOKING TIME; ALL OTHER FACTORS CONSTANT

Cook Numbers	E 12-14	E 15-16	E 8-9	E 18-19
Moisture in Chips, %	48.0	48.0	48.0	48.0
Total Alkali on moisture-free Wood, %	30.0	30.0	30.0	30.0
Causticity of Liquor, %	83.0	83.0	82.0	83.0
Sulphidity of Liquor, %	26.0	26.0	26.0	26.0
Liquor per 100 lb. moisture-free Chips, gal.	40.0	40.0	40.0	40.0
Cooking time, hours	3	3½	4.0	4½
Temperature (max.), °F.	350	350	350	350
Pressure, p.s.i.	115	115	115	115
To Temperature, hours	1½	1½	1½	1½
Yield on Air-dry Wood, %	50.8	49.6	48.6	48.0
Screenings on Air-dry Wood, %	2.1	1.4	0.9	0.6
Causticity of Spent Liquor, %	24.0	22.1	16.8	14.3
Na_2CO_3 of Spent Liquor, g./l.	54.6	58.0	58.4	54.6
Permanganate No. (TAPPI)	26.0	19.6	18.4	14.2
Brightness (unbleached), %	22.4	25.4	27.4	25.1

Note: Total alkali expressed in terms of sodium carbonate.

BLEACHING DATA

Chlorine used 1st stage, %	5.4	5.1	4.3	3.1
pH End of 1st stage	1.8	1.9	2.0	2.0
Caustic used 2nd stage, %	1½	1½	1½	1½
pH End of 2nd stage	10.0	10.2	10.1	10.3
Chlorine (Hypo) used 3rd stage, %	1.8	1.3	1.1	1.0
pH End of 3rd stage	8.5	8.4	8.5	8.3
Caustic used 4th stage, %	0.5	0.5	0.5	0.5
pH End of 4th stage	10.6	10.4	10.8	10.6
Chlorine (Hypo) used 5th stage, %	0.9	0.8	0.8	0.8
pH End of 5th stage	8.4	8.5	8.4	8.4
Chlorine (Hypo) used 6th stage, %	0.2	0.1	0.6	0.9
pH End of 6th stage	8.3	8.4	8.5	8.5
Total Chlorine used, %	8.3	7.3	6.8	5.8
Brightness, %	80.6	81.2	80.4	81.7

STRENGTH (Tear)

Beating time, minutes				
5	290	310	310	320
25	300	290	296	310
45	260	270	284	288
65	200	220	265	275
75	170	180	268	270
85	154	160	246	242
95	140	135	210	220

BURST (Mullen)

Beating time, minutes				
5	92	94	90	100
25	148	152	170	130
45	165	170	164	148
65	150	148	164	165
75	148	142	158	175
85	140	142	152	160
95	128	130	158	158
Tear value	560	560	580	598
Burst value	313	322	334	278
Pulp value	873	882	914	876

TABLE III.—SERIES 3. MILL COOKS. VARYING THE COOKING TIME; ALL OTHER FACTORS CONSTANT

Cook Numbers	M-1	M-2	M-3	M-4
Moisture in Chips, %	48.0	48.0	48.0	48.0
Total Alkali on moisture-free Wood, %	30.5	30.5	30.5	30.5
Causticity of Liquor, %	82.0	83.4	84.0	83.6
Sulphidity of Liquor, %	25.2	24.4	25.8	24.6
Liquor per 100 lb. moisture-free Chips, gal.	24.0	24.0	24.0	24.0
Cooking Time, hours	2½	3½	4.0	5.0
Temperature (max.), °F.	328	326	328	330
Pressure, p.s.i.	80	80	80	80
To Temperature, hours	1¼	1¼	1¼	1¼
Permanganate number (TAPPI)	30.2	28.4	26.5	21.9

Note: Total alkali expressed in terms of sodium carbonate.

STRENGTH (Tear)

Beating time, minutes				
5	310	287	295	296
25	246	208	244	237
45	223	173	208	189
65	194	168	196	166
75	179	163	184	158
85	166	160	180	150
95	135	142	148	146

BURST (Mullen)

Beating time, minutes				
5	75	89	89	89
25	119	163	150	152
45	141	168	170	168
65	164	170	165	165
75	161	159	155	153
85	153	145	147	141
95	131	137	140	139
Burst value	260	331	320	320
Tear value	469	381	452	426
Pulp value	729	712	772	746

TABLE IV.—SERIES 4. MILL COOKS. VARYING VOLUME OF LIQUOR; ALL OTHER FACTORS CONSTANT

Cook Numbers	M-5	M-6	M-7	M-8	M-9
Moisture in Chips, %	50.0	50.0	50.0	50.0	50.0
Total Alkali on moisture-free Wood, %	27.5	27.5	27.5	27.5	27.5
Causticity of Liquor, %	84.0	83.4	84.2	83.6	83.8
Sulphidity of Liquor, %	26.2	26.7	26.3	25.4	25.6
Liquor per 100 lb. moisture-free Chips, gal.	36.0	25.0	24.0	22.0	20.0
Cooking Time, hours	2.0	2.0	2.0	2.0	2.0
Temperature (max.), °F.	350	348	348	352	350
Pressure, p.s.i.	115	115	115	115	115
To Temperature, hours	1½	1½	1½	1½	1½
Permanganate No. (TAPPI)	30.5	31.4	30.7	30.1	30.2

Note: Total alkali expressed in terms of sodium carbonate.

STRENGTH (Tear)					
Beating time, minutes					
5	268	342	294	308	302
25	195	268	240	256	252
45	151	212	198	244	218
65	136	191	167	196	188
75	126	180	155	161	158
85	104	150	152	159	146
95	105	126	145	125	144
BURST (Mullen)					
Beating time, minutes					
5	59	90	97	99	98
25	142	139	144	144	145
45	154	164	157	172	150
65	145	148	171	164	155
75	134	147	165	152	140
85	125	143	144	148	139
95	126	135	128	134	135
Burst value	296	305	300	316	295
Tear value	346	480	438	480	470
Pulp value	642	783	738	796	765

No attempt will be made to draw any definite conclusions from the foregoing data. It seems, however, that the following points are worthwhile and justifiable, when based on the data presented in this report:

1. The 4-hour cooks made by varying the total chemical charge from 24.0% total alkali based on moisture-free wood to 32.0% produced pulps with permanganate numbers ranging from 28.6 to 13.4; and yields ranging from 51.4% to 47.8% air-dry pulp based on moisture-free wood. The bleach consumption necessary to produce a G.E. brightness around 80.0% varied from 11.5% to 4.1% as the concentration of the cooking liquor was increased.

2. Cooking with 30.0% total alkali based on moisture-free wood produced pulps with permanganate numbers ranging from 26.0 to 14.2 and yields from 50.8% to 48.0% air-dry pulp based on moisture-free wood. The bleach consumption varied from 8.3% to 5.8% as the cooking time was increased from three to four and one half hours.

3. Cooking in the mill digester with 30.5% total alkali based on moisture-free wood and varying the cooking time from two and one third hours to five hours, at 80 p.s.i. pressure produced pulps with permanganate numbers ranging from 30.2 to 21.9.

4. Cooking in the mill digester with 27.5% total alkali based on moisture-free wood by varying the volume of cooking liquor charged on a hundred pounds of moisture-free chips from 36.0 to 20.0 gallons, produced unbleached pulps with permanganate numbers from 30.5 to 30.2. In fact the change in volume had very little effect on the permanganate numbers.

5. From the standpoint of bleached pulp, the best strength characteristics were produced from the pulps having permanganate numbers around 14 to 18, and it did not seem to matter whether the pulp was made by cooking longer or increasing the chemical charge.

6. From the standpoint of unbleached pulp the best strength characteristics were produced by cooking at 115 p.s.i. pressure, and a volume of 24 gallons per hundred pounds of moisture-free chips.

7. The bleached pulps showed higher strength characteristics than the unbleached pulps. There are two factors that may account for this: namely,

A. The bleached pulps were made in the small laboratory digester with a circulating pump.

B. The bleached pulps were made from wood cut at a different season of the year than the wood used to make the unbleached pulps.

8. In general, it seems that the highest quality pulp was produced by cooking to a permanganate number around 30.0 with a 115 p.s.i. pressure for unbleached pulp and a permanganate number around 16.0 for a bleached pulp.

Delaware Valley TAPPI Discusses Dyestuffs

The Delaware Valley Section of the Technical Association of the Pulp and Paper Industry met at the Engineers Club, Philadelphia, Pa., on Friday, April 2, 1943. J. D. Davis of Dill & Collins, Inc., presided as chairman.

The speaker was Fred A. Soderberg, Head of the Paper Department of the General Dyestuffs Company, who talked on Dyestuff Variables. Mr. Soderberg discussed the many variables which the paper maker must overcome in order to satisfactorily color a sheet of paper. A few of the points illustrated by charts were:

The effect of organic and inorganic materials contained in the water supply.

Cooking conditions, source of food, and lignin content were cited as reasons for variable retention of dyestuffs by the paper fiber.

Absorption which is governed to some extent by the electrolytic charge of the fiber.

Galvanic action between metals and dyestuff that will materially affect the shade of the finished product.

Hit or miss addition of the numerous chemicals, including size, color and alum can only cause ununiform dyeing.

The chemical reactions that take place between the various dyestuffs commonly used for paper coloring.

Color lakes are formed that may have fastness properties which are either superior or inferior to the components of a particular dyestuff combination. The shade and strength may also be altered appreciably.

Changes in depth and light reflection that are produced by beating, jordaning or excessive mixing in the chests.

Evenness of coloring can only be maintained by close supervision over stock preparation.

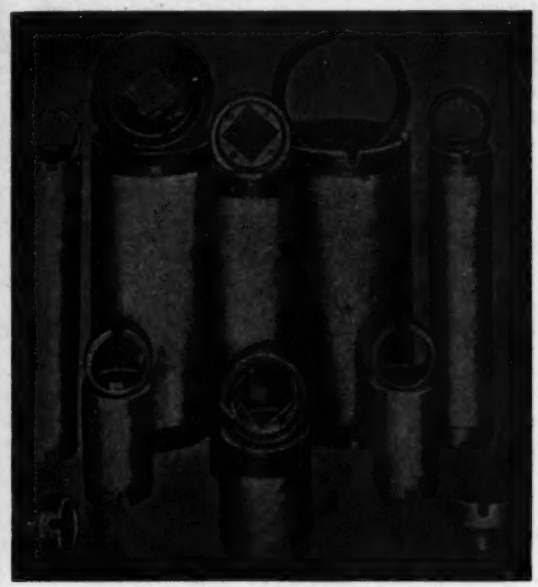
The uniform control of acidity or alkalinity is very beneficial to the dyeing process.

In a procedure as flexible as the coloring of paper, it was said that the dyestuffs must conform with other manufacturing requirements.

In connection with the "war effort", the use of camouflage was discussed in detail. The success which dyestuff manufacturers have had in producing shades which blend perfectly with the surrounding terrain was illustrated.

Camouflage colors are now available which will give the same effect as the natural materials when photographed with the infrared camera, the panchromatic camera or when viewed by the human eye.

Those present included A. L. M. Bixle, Carl L. Bosch, F. W. Brainerd, S. M. Biatton, K. W. Britt, William J. Burke, L. K. Burnett, C. M. Connor, O. C. Cordes, J. D. Davis, George Detwiler, D. Dieffenderfer, J. C. Dieffenderfer, J. Edge, Paul Easton, H. J. Farra, Jesse Good, E. N. Glauner, Lois V. Hans, H. F. Hoffman, Harry Hulmes, V. Jacobsen, George J. Lane, Wm. D. Marshall, George B. Martin, Louise E. McGrath, D. Kenneth McCurdy, Edward C. Molin, A. H. Nadelmann, N. H. Pangbrey, E. N. Poor, R. J. Proctor, M. B. Pineo, J. F. Reardon, A. W. Redling, Edward A. Shallcross, William M. Shoemaker, F. A. Soderberg, Henry C. Speel, G. M. Suydam, A. E. Waugh, A. H. Webber, W. O. Wilkinson, and T. S. Wolfinger, Jr.



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Straight wound paper cores made in sizes from 2" to 10" inside diameter with any thickness wall required.

Long draw protected slot caps of heavy gauge steel in all standard sizes.

Heavy duty caps with reenforced square hole. This patented feature of reenforcement gives added strength and durability.

CORES

Samples of caps or cores will be gladly submitted

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CORINTH, N. Y.

COMPLETE RECAUSTICIZING PLANTS

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FOR 20 years Dorr Continuous Recausticizing Systems have been the symbol of trouble-free operation in the production of causticizing liquors for the Pulp and Paper Industry.

Today—based on this 20 years experience we are prepared to do the whole job—to engineer and design *complete* recausticizing plants. Development of flowsheets and determination of operating costs—engineering design and specifications for construction—purchase of all equipment—and supervision of initial operation—all are our responsibility.

We'd like the opportunity to tell you more about it. Meanwhile it's our job to keep our end up—to keep present Dorr installations running smoothly at peak production. If you need help—call on us.

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Summarizes Wood Pulp Allocations

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 7, 1943.—The increasing shortage of certain grades of wood pulp necessitates a more general use of groundwood, newsgrade unbleached sulphite, de-inked waste fiber and other waste papers in paper and paper board manufacturing, the WPB Pulp and Paper Division stated in connection with the April wood pulp allocations.

The attention of the Wood Pulp Allocation Industry Advisory Committee was focused on this problem during its March meeting held in Washington.

The summary of wood pulp allocations for April follows:

Bleached Sulphite: The supply of bleached sulphite continued short relative to current consumption. Allocations of market pulp were again on the basis of a 30-day inventory in the hands of non-integrated mills. As de-inking plants are currently operating at less than capacity, their operations must be raised wherever possible. If bleached sulphite consumption continues at the present level, future allocations may have to be curtailed below 30 days and other grades of pulp substituted for the deficiency.

Strong Unbleached Sulphite: Strong unbleached sulphite was allocated on the basis of a 45-day inventory. The supply situation in this grade will, of course, be affected if it is substituted for bleached sulphite to meet future shortages.

Newsgrade Unbleached Sulphite: This grade is in relatively ample supply. Its increased use is urged as a means of conserving the better grade pulps.

Bleached Sulphate: Allocations of this grade were made to provide consumers with roughly a 30-day inventory. The supply of northern grades is relatively scarcer than the southern but shortages are serious in both.

Unbleached Sulphate: Allocations were on a 30-day basis in both the northern and southern grades. The market supply of Southern Kraft continues to be restricted by shortages of pulpwood and increased requirements for container board.

Soda: It was only possible to allocate enough to maintain an estimated 30-day inventory as of April 30 in this grade. Consumption will have to be curtailed if inventories are to be maintained at this level.

Groundwood: This grade, like newsgrade sulphite, is easier than most others. Some consumers are already introducing groundwood into papers where it was formerly not used and increased groundwood consumption is necessary to relieve the shortage in other grades.

General Preference Order M-93 (issued to control the supply and direct the distribution of wood pulp) has been in operation for one year. Inventories of most grades of pulp are down to a 30-day average basis. Unless there is either decreased consumption or increased production of bleached sulphite, bleached and unbleached sulphite, strong unbleached sulphite and soda pulp, it will be necessary to substitute groundwood and newsgrade unbleached sulphite to compensate for the shortage.

Increased use of old papers ise a partial solution, but groundwood and newsgrade sulphite must necessarily be used in papers formerly manufactured only from the higher grades of wood pulp. Allocations under M-93 can be employed to accomplish this result, but any voluntary adjustments which pulp consumers make will assist materially in balancing the pulp budget.

In response to recent appeals to the industry, Forms PD-290, PD-291, and PD-292 were filed on time by the great majority of producers and consumers in March. This eased the work of the Pulp and Paper Division materially and it is hoped the good record will continue.

Empire State Discusses Emulsions

The Hudson River Group of the Empire State Section of the Technical Association of the Pulp and Paper Industry met at the Queensbury Hotel, Glens Falls, N. Y., on April 1, 1943. F. J. McCourt of the International Paper Company presided as chairman. Arrangements for the meeting were taken care of by Foster P. Doane, Jr. L. R. Sherman of the National Oil Products Company talked on "The Application of Emulsions and Emulsifiers to Paper Making." The General Electric Company film "Curves of Color" was shown. This film describes the spectrophotometer and its use.

The next meeting will be held in Glens Falls on May 6th. "Employee Relations and Training" will be the subject discussed.

Those present included: Wm. Beazley, W. R. Blood, R. G. Blanchard, R. T. Bingham, A. B. Copping, W. F. Curtis, F. P. Doane, J. K. Donohue, R. M. Drummond, R. S. Duell, H. J. De Soe, V. P. Edwards, H. W. Fales, S. L. Foster, F. N. Foster, T. A. Gastonguay, M. Gormley, F. B. Halloran, A. G. Hatcher, J. W. Joslyn, Wm. Leeson, A. A. Lowe, F. P. Marrs, F. J. McCourt, C. J. McIntire, S. McLandress, W. D. Mooney, J. Morrison, H. Newell, A. Prestera, F. E. Pasco, T. Rider, L. R. Sherman, R. E. Stearns, F. J. Sheehan, L. Thompson, E. J. Trimbey, R. A. Thomson, M. G Tibbets, M. Wells, Wm. Barr, L. G. Gallup and R. A. Secord.

Joins Bermingham & Prosser

James K. Hutchison, formerly vice-president of Allied Paper Mills, Inc., and in charge of the New York office, has resigned to join the Bermingham & Prosser Co., as special representative.

Mr. Hutchison has been connected with the Allied Paper Mills for nineteen years, first as accountant and office manager and as salesman. In 1932 he was made co-manager of the Eastern Division of the Allied Paper Mills and in 1933 became vice-president. He is a former vice-president of the Salesmen's Association of the Paper Industry and is chairman at the New York office of the Bermingham & Prosser Co., 10 East 40th street.

Powell River Remits Rent for Week

When it was forced to close down for a week recently, the Powell River Company posted notice at its paper mills at Powell River, B. C., advising employees that while vacations for 1943 were not due until May 1, the company was agreeable to granting paid vacations during the week in which the mill was shut down.

At the same time rents in the townsite were remitted to employees for the shut down week and a deduction was made from the remission for each day worked as a certain number of employees continued on duty intermittently during the close down.

WE WANT IDEAS

FROM MACHINERY MANUFACTURERS . . .
INVENTORS • PLANT MANAGERS . . .
MACHINE OPERATORS . . .

The Hudson-Sharp Machine Company has devoted a period of 65 years to the development and manufacture of various types of machines used by manufacturers of paper and paper board products. During that period we have originated and improved many of the machines now used in this industry.

During 1942 and to date in 1943 we have turned our entire shop facilities to the manufacture of equipment for the Army and Navy. We have, during this period, increased the size of our plant and have added new tools and equipment.

We will continue to operate our plant for defense as long as the government requires our services but in the meantime we must, with industry in general, devote some attention and planning to post-war problems so that we may keep our present employees busy and provide places for men from our plant who are in the armed service.

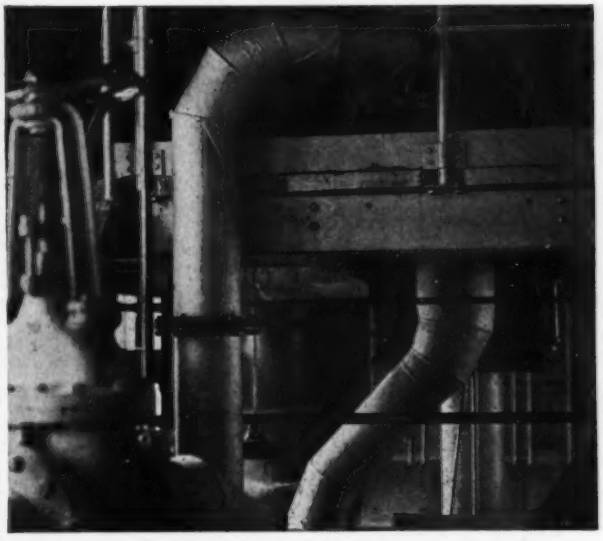
We want to improve the machines we have manufactured previously. We want to add new and needed equipment to our line. We appreciate that men in the paper industry have a large store of ideas which they would like to have developed and placed in use.

To this end we offer our services. We will cooperate with any manufacturer desiring larger production of machines he has heretofore been manufacturing on a limited scale. We will take the inventions of those who have designed equipment for the paper and paper board trade, develop these plans and manufacture the machines for the inventor to sell, or will sell them through our own sales organization. We will meet with plant managers and machine operators who have ideas for improving our machines or for new machines with a view to cooperating with them in the development of their ideas.

We offer this service on a cooperative basis under arrangements which will be mutually and satisfactorily agreed upon. We invite your correspondence with a view to arranging a personal contact.

HUDSON-SHARP
MACHINE CO • GREEN BAY • WIS

THE PIPE OF PEACE HAS GONE TO WAR



The same ARMCO Spiral Welded Pipe that was the logical choice of so many mills for peacetime water supply lines and plant piping is now being used only on vital war projects.

In this new service it meets wartime standards for efficient, maintenance-free performance. ARMCO Pipe is prefabricated to fit the layout. Fewer joints are the rule because fittings come welded to straight pipe runs. The pipe can be prime coated on the outside only, or hot-dip galvanized after fabrication. For water lines, ARMCO Pipe has a spun enamel lining that assures sustained carrying capacity.

If you can't get ARMCO Spiral Welded Pipe now, remember that Victory comes first. The steel is needed for ARMCO pipe in ships, ordnance and construction for the fighting fronts. After the war ARMCO Pipe will be ready again to help solve your most difficult piping problems. The American Rolling Mill Co., Pipe Sales Division, Middletown, Ohio.

ARMCO
SPIRAL WELDED PIPE

New York Paper and Pulp Market Review

OPA Sets Higher Maximum Kraft Paper Prices in Sales By Manufacturers—New Paper Board Price Schedule Is Issued For Eastern States — WPB Summarizes April Wood Pulp Situation.

Office of the PAPER TRADE JOURNAL.
Wednesday, April 7, 1943.

Wholesale demand for paper continues to be reported active in reports received from most of the many manufacturers' representatives, jobbers, and general paper merchants during the current week.

The index of general business activity for the week ended March 27 rose to 138.2, from 137.0 for the previous week, compared with 133.8 for the corresponding week last year. The index of paper board production was 148.7, compared with 148.1 for the previous week, and with 166.1 for the corresponding week last year.

Paper production for the week ended March 27 was estimated at 89.7%, compared with 103.4% for 1942, with 94.5% for 1941, with 82.3% for 1940, and with 86.2% for the corresponding week for 1939.

Paper board production for the week ended March 27 was 95.0%, compared with 101.0% for 1942, with 84.0% for 1941, with 67.0% for 1940, and with 74.0% for the corresponding week for 1939.

Sales of paper and its products declined 18% in February, 1943, from the like month last year, according to the Department of Commerce. Inventories at the end of February, 1943 were 3% less than for February, 1942, and 1% less than in January, 1943.

The New Revised OPA Price Schedule No. 32, Amendment No. 6, permits higher kraft paper maximum prices in sales by manufacturers. Base prices, per cwt. on 30-lb. standard wrapping are $4.75; No. 1 wrapping, $5.00; superstandard, $5.25; imitation kraft wrapping, 4.50; standard unbleached butchers, $5.00; No. 1 unbleached butchers, $5.25; machine glazed, $5.50; standard bag, $4.375; variety bag, $4.625; and machine glazed bag, $5.25.

New Revised Price Schedule No. 32, Amendment No. 4, establishes paper board prices east of the Rocky Mountains on liners and corrugating grades. The prices on kraft liners, 50-lb. per M. sq. ft. is $1.58; 72 lb. $2.27; strawboard, .96; 26-lb. kraft, .82; chestnut, .78; bogus, .90, and Canadian sulphite and groundwood, .78.

Wood Pulp

The War Production Board announced on April 2, that increasing shortages of certain grades of chemical wood pulp would necessitate a more general use of groundwood, news grade of unbleached sulphite, de-inked papers and other waste papers in the manufacture of paper and paper board. Summarizing the wood pulp allocations for April, the WPB stated that the supply of bleached sulphite continued short relative to current consumption, with allocations on the basis of a 30-day inventory in the hands of non-integrated mills. Strong unbleached sulphite was allocated on the basis of a 45-day inventory. News grade, unbleached sulphite is in ample supply. Bleached sulphate allocations were made, roughly, on a 30-day inventory. Unbleached sulphate allocations were made on a 30-day basis, in both northern and southern grades. Groundwood is easier.

Rags

The OPA on April 5, stated that wholesale sellers of waste rags, ropes and strings, for papermaking, may not add to their maximum prices the cost of transporting those materials to their places of business. "Maximum prices are to be applied f.o.b. point of shipment, which is the point where the goods are first loaded on freight cars, trucks or barges for transportation to the buyer." The agency points out that, "This is not to be construed to permit the addition of inbound freight charges."

Old Rope and Bagging

Demand for scrap bagging is active, with mills reported paying ceiling prices. The OPA issued on April 2, Amendment No. 48 to GMPR, placing under the general regulation scrap bagging, burlap, bagging or bale coverings composed of jute, hemp, istle, sisal or similar fibers.

Waste Paper

Prices on No. 1 mixed paper and on folded news are currently a little lower than ceiling prices under less active mill purchasing. Amendment No. 1 to Maximum Price Regulation No. 30, effective April 2, allows dealers to pack, without price penalty, No. 1 heavy books and magazines, and mixed books, by optional methods; in bundles or on skids for heavy books and in bundles or bags for mixed books.

Twine

Demand for twine and cordage continues to outrun supply. Manila fiber is now practically unobtainable for most civilian uses. Sisal is now commonly substituted for agricultural and other essential non-military uses.

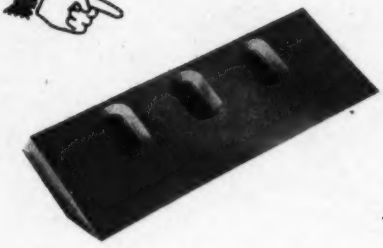
Forms Pulpwood Advisory Committee

[FROM OUR REGULAR CORRESPONDENT]

WASHINGTON, D. C., April 7, 1943—The Director of the Industry Advisory Committees of WPB has just announced the following Canadian Pulpwood Industry Advisory Committee with David Graham as Government Presiding Officer. The members of the Committee include the following: F. C. Ash, Oswego Falls Corporation, Fulton, N. Y.; C. G. Parker, Kimberly-Clark Corporation, Neenah, Wis.; Folke Becker, Rhinelander Paper Company, Rhinelander, Wis.; Hugh J. Chisholm, Oxford Paper Company, New York, N. Y.; Stuart B. Copeland, Northwest Paper Company, Cloquet, Minn.; A. B. Hansen, Northern Paper Mills Company, Green Bay, Wis.; William Hilton, Great Northern Paper Company, Boston, Mass.; Janet Russell, Ryegate Paper Company, Ryegate, Vt.; Arthur H. Showalter, Mt. Tom Sulphite Pulp Company, Mt. Tom, Mass.; H. R. Telfer, Detroit Sulphite Pulp and Paper, Detroit, Mich.; N. W. Wilson, Hammermill Paper Company, Erie, Pa.; Herman Schanche, Brown Company, Berlin, N. H.

MORE THAN FINE STEEL

Makes Heppenstall Chipper Knives



You can't buy better steels for the purpose than those Heppenstall produces for its own Chipper Knives. But it takes more than good metal to make good knives. Add the ingredient of precision manufacture based upon more than fifty years experience in the forging of fine steels and you have a good reason for specifying Heppenstall when your knives need replacement. Current Priority Ratings: E.I.S. alloy steel A-1-J or better; special carbon steel A-10 or better. Address Heppenstall Company, Pittsburgh, Pa.

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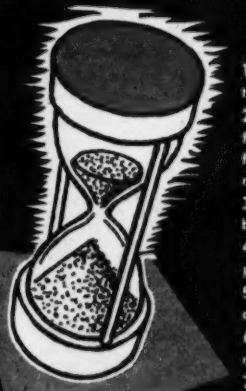
12 WAYS TO ADD LIFE TO YOUR FELTS



To help you get more wear from your felts and thereby save wool, Orr presents this check list for your help and information.

1) Do you check suction box covers for splinters and abrasives and dress them frequently?

2) Do you examine rolls, boxes, and journals for surface grease and remove at once if found, before attempting to place felt on machine?

3) Have you recently checked felt rolls for balance? For free turning?

4) Is your felt cleaner, particularly those parts touching the felt, in excellent condition?

5) Are you sure that your felt stretchers are operating freely?

6) Do you know if the crowning of your press rolls is correct? Are these rolls in alignment?

7) Are you sure your whipper arms are operating evenly and with correct amount of whip?

8) Are holes in shower pipes open and applying correct spray?

9) Do you check water temperature and insist that correct temperatures be maintained?

10) Have you checked for presence of iron hydroxide in the water, the chemical that makes felts stiff and boardy?

11) Are deckles on board machines smooth and free from rough edges?

12) Have Orr Sales Engineers told you the latest method of cleaning, drying, and storing felts?

Orr Felt representatives are eager to help you. Call for them when reordering felts or when needing assistance.

ORR FELTS THE ORR FELT AND BLANKET CO., PIQUA, OHIO

MISCELLANEOUS MARKETS

Office of the PAPER TRADE JOURNAL.
Wednesday, April 7, 1943.

BLANC FIXE—Quotations on blanc fixe are firm and continue unchanged at prevailing market levels. The pulp is currently quoted at $40 per ton in barrels, at works; the powder is offered at $60 per ton, f.o.b. works. Demand reported fair for the week.

BLEACHING POWDER—Prices on bleaching powder are firm. Current demand reported good. Bleaching powder is currently quoted at $2.50 per 100 pounds, in drums, at works.

CASEIN—Quotations on casein are unchanged for the week. Standard domestic casein, 20-30 mesh, is quoted at 19 cents per pound; 80-100 mesh at 19½ cents per pound; all prices in bags, car lots.

CAUSTIC SODA—Prices on caustic soda are reported unchanged. Demand for the current week is reported heavy. Solid caustic soda is currently quoted at $2.30 per 100 pounds; flake and ground at $2.70 per 100 pounds, in drums, at works.

CHINA CLAY—Quotations on china clay are firm and continue unchanged. Demand reported fair for the current week. Domestic filler clay is currently quoted at from $7.50 to $15 per ton; coating clay is quoted at from $12 to $22 per ton at mine. Imported clay is quoted at from $13 to $25 per long ton, ship side.

CHLORINE—Quotations on chlorine unchanged. Government demand for war use continues heavy. Prices firm. Chlorine is currently quoted $1.75 per 100 pounds, in single-unit tank cars f.o.b. works.

ROSIN—Quotations on some grades of rosin are unchanged for the current week. "G" gum rosin is currently quoted at $3.51 per 100 pounds, in barrels, Savannah. "FF" wood rosin is currently quoted at $3.49 per 100 pounds in barrels, New York. Seventy per cent gum rosin size is currently quoted at $3.70 per 100 pounds, f.o.b. works.

SALT CAKE—Prices on salt cake are firm. Demand reported moderate for the current week. Domestic salt cake is currently quoted at $15 per ton in bulk; chrome salt cake at $16 per ton. All prices in car lots, f.o.b., shipping point. Quotations on imported salt cake are nominal at $16 per ton.

SODA ASH—Quotations on soda ash are firm and continue to conform to prevailing market quotations. Demand good. Quotations on soda ash in car lots, per 100 pounds, are as follows: in bulk, $.90; in paper bags, $1.05; and in barrels, $1.35.

STARCH—Prices on corn starch continue to be reported unchanged for the current week. Pearl is currently quoted at $3.10 per 100 pounds; powdered starch at $3.20 per 100 pounds. All prices in bags, car lots, f.o.b., Chicago.

SULPHATE OF ALUMINA—Quotations on sulphate of alumina are firm. Demand reported improved. The commercial grades are currently quoted at $1.15 per 100 pounds; iron free at from $1.75 to $1.85 per 100 pounds, in bags, car lots, f.o.b., works.

SULPHUR—Prices on sulphur are firm and continue to conform to prevailing market quotations. Annual contracts are currently quoted at $16 per long ton, f.o.b., mines. Spot and nearby car lots are quoted at $18 per ton.

TALC—Quotations on talc are firm and continue unchanged at prevailing market prices. Domestic talc is currently quoted at from $16 to $21 per ton, at mills. No quotations on imported talc.

MARKET QUOTATIONS

All market quotations, excepting those otherwise designated as official OPA maximum prices, are based on the manufacturers' price level as of October 1-15, 1941; maximum wholesale prices are based on the merchants' maximum prices for stipulated quantities at a quoted price to all customers of a like class, as shown by the merchant's sales records of goods delivered during March, 1942. A merchant's price list in effect in March 1942, showing quotations of actual shipments, will establish the current maximum prices.

Paper

(Delivered New York)

News, per ton—

Roll, contract	*$54.00	@	—
Sheets	62.00	"	—

* OPA Maximum Price.

Kraft—per cwt.—Carload Quantities Zone A, f.o.b. Mill

Superstandard Wrapping	*$5.25	@	—
No. 1 Wrapping	*5.00	"	—
Standard Wrapping	*4.75	"	—
Standard Bag	*4.375	"	—

* OPA Manufacturers' Prices.

Tissues—Per Ream—Carlots

White No. 1	1.12½	"	—
White No. 1 M. G.	1.05	"	—
White No. 1½	1.00	"	—
White No. 2	1.00	"	—
Anti-Tarnish M. G.	.95	"	—
Colored	—	"	—
Kraft	.95	"	—
Manila	.90	"	—

Toilet—1 M. Sheets—Per Case

Unbleached	4.16	"	—
Bleached	5.70	"	—
Unbl. Toilet, 1 M.	4.16	"	—
Bleached Toilet	5.70	"	—

Paper Towels, Per Case—

Unbleached, Jr.	2.35	"	—
Bleached, Jr.	2.65	"	—

Manila—per cwt.—C. l. f. a.

No. 1 Jute	11.25	@	—
No. 1 Manila Wrapping, 35 lb.	5.50	"	5.75
No. 2 Manila Wrapping, 35 lb.	5.25	"	5.50

Boards, per ton—

News	*48.00	@	—
Chip	*45.00	"	—
Sgl. Mla. Ll. Chip	*60.00	"	—
White Pat. Coated	*75.00	"	—
Kraft Liners 50 lb.	*63.00	"	—
Binders Boards	84.00	"	116.00

* OPA Base Prices per 10 tons. Less than 10 tons but over 3 tons, add $2.50; three tons or less, add $5; regular 35-39 basis, add $5.; basis 40-49, add $2.50; basis 91-100, add $2.50; basis 101-120, add $5.

The following are representative of distributors' resale prices:

Rag Content Bonds and Ledgers—White, Assorted Items, Delivered in Zone 1:

	Bonds		Ledgers	
100% Rag Ext. No. 1	$39.10	@$46.00	$40.25	@$47.25
100% Rag	32.20	" 37.75	33.35	" 39.25
85% Rag	....	"	29.90	" 35.00
75% Rag	23.00	" 27.00	24.15	" 28.25
65% Rag	....	"	22.80	" 27.75
50% Rag	18.70	" 22.75	19.90	" 24.25
35% Rag	16.40	" 20.00	17.55	" 21.50

Colors at $1.00 cwt. extra.

Sulphite Bonds and Ledgers—White, Assorted Items. Delivered in Zone 1:

	Bonds		Ledgers	
No. 1..	$10.55	@$12.75	$11.70	@$14.25
No. 2..	9.65	" 11.75	10.80	" 13.25
No. 3..	9.20	" 11.25	10.35	" 12.50
No. 4..	8.90	" 10.75	10.05	" 12.25

Colors $1.00 cwt. extra.

Free Sheet Book Papers—White, Cased Paper. Delivered in Zone 1:

No. 1 Glossy Coated	$13.65	@	$15.50
No. 2 Glossy Coated	12.40	"	14.00
No. 3 Glossy Coated	11.60	"	13.25
No. 4 Glossy Coated	11.15	"	12.75
No. 1 Antique (watermarked)	10.25	"	11.75
No. 2 Offset	9.60	"	11.00
A Grade E. F.	9.35	"	10.75
A Grade S. & S. C.	9.60	"	11.00
B Grade E. F.	8.85	"	10.25
B Grade S. & S. C.	9.10	"	10.50
C Grade E. F.	8.55	"	9.75
C Grade S. & S. C.	8.80	"	10.00
D Grade E. F.	8.25	"	9.50
D Grade S. & S. C.	8.50	"	9.75

Ivory & India at $.50 cwt. extra.

Wood Pulp

OPA Maximum Prices and Canadian Manufacturers Prices, Less Freight to Destination.

Bl. Softwood Sulphite	$76.00
Unbl. Softwood Sulphite	65.00@ 66.00
Bl. Hardwood Sulphite	73.50
Unbl. Hardwood Sulphite	63.50
Bl. Mitscherlich	81.00
Unbl. Mitscherlich	73.00
N. Bleached Sulphate	86.00
S. Bleached Sulphate	79.00
N. Semi-Bleached Sulphate	62.00
S. Semi-Bleached Sulphate	75.00
N. Unbl. Sulphate	73.00
S. Unbl. Sulphate	63.50
Bl. Soda	66.00
Unbl. Soda	62.00
Groundwood	46.00

Transportation Allowances Applying to Producers of Wet Wood Pulp.

Below 50% Air Dry Weight	
Northeast	$13.50
Lake Central	13.50
Southern	16.00
West Coast (in area)	10.50
West Coast (out area)	16.50

50%-80% Air Dry Weight	
Northeast	$11.50
Lake Central	11.50
Southern	14.00
West Coast (in area)	9.50
West Coast (out area)	15.50

Applying to Producers of Dry Wood Pulp.

Above 80% Air Dry Weight	
Northeast	$8.50
Lake Central	8.50
Southern	11.00
West Coast (in area)	7.50
West Coast (out area)	13.50

Should freight charges actually exceed these allowances, the difference may be added to the maximum prices.

Domestic Rags

New Rags

(Prices to Mill f. o. b. N. Y.)

Shirt Cuttings—			
New White, No. 1	*7.25	@	—
Silesias No. 1	*5.75	"	—
New Unbleached	*7.50	"	—
Blue Overall	*5.50	"	—
Fancy	*3.50	"	—
Washables	*3.00	"	—
Bleachable Khaki Cuttings	*4.25	"	—
Unbleachable Khaki Cuttings	*3.50	"	—

* OPA Maximum Prices.

SCREENS for PAPER and PULP MILLS

PERFORMANCE of your Centrifugals, Shakers and Drainers definitely improved by the use of precision screens built to your specifications. Let us "sit in" on your screening problems.

The Harrington & King PERFORATING Co.

5652 Fillmore St., Chicago — 114 Liberty St., New York

West Virginia Pulp and Paper Company

230 Park Ave. New York
35 East Wacker Drive Chicago
Public Ledger Building Philadelphia, Pa.
503 Market St. San Francisco, Cal.

Manufacturers of

ENGLISH FINISH SUPERCALENDERED
MACHINE FINISHED BOOK
and LITHOGRAPHIC PAPERS

Offset, Envelope, Bond, Writing, Mimeograph, Ledger, Eggshell, Cover and Music Papers, Index Bristol, Post Card and Label Papers

HIGH GRADE COATED BOOK

• • • •

KRAFT WRAPPING AND KRAFT ENVELOPE
KRAFT LINER BOARD
BLEACHED SULPHITE AND SODA PULP
BLEACHED AND UNBLEACHED KRAFT PULP

MILLS:

Mechanicville, New York
Luke, Maryland
Covington, Virginia
Tyrone, Pennsylvania
Williamsburg, Pennsylvania
Charleston, South Carolina

More than just a TRADE MARK

EXCELSIOR KNOX Woolen Co. Camden, Me. FELTS & JACKETS

BUT also a guarantee by men who for 78 years have prided themselves in making finer felts. TO YOU —this is the mark of dependability, longer felt life and greater saving.

KNOX WOOLEN CO.
CAMDEN, MAINE.

PRICE & PIERCE »»»»»»»ltd•

Wood Pulp & Paper Agents

60 East 42 Street
New York, N. Y.

Old Rags

White, No. 1—			
Repacked	*3.80	"	—
Miscellaneous	*3.20	"	—
White, No. 2—			
Repacked	*2.90	"	—
Miscellaneous	*2.65	"	—
Third and Blues—			
Repacked	*2.20	"	—
Miscellaneous	*1.80	"	—
Roofing Rags—			
No. 1	*1.55	"	—
No. 2	*1.45	"	—
No. 3 (bagging)	*1.35	"	—
No. 4	*1.35	"	—
No. 5A	*1.35	"	—
Old Manila Rope	5.75	"	—

OPA Maximum Prices.

Foreign Rags

All Prices nominal

New Rags

New Dark Cuttings	2.25	@	2.40
New Mixed Cuttings	2.00	"	2.20
New Light Silesias	5.50	"	5.75
Light Flannelettes	5.50	"	5.75
New White Cuttings	7.00	"	7.50
New Light Oxfords	4.00	"	4.50
New Light Prints	3.00	"	3.25

Old Rags

No. 1 White Linens	7.50	"	8.50
No. 2 White Linens	6.50	"	7.50
No. 3 White Linens	4.50	"	—
No. 4 White Linens	2.25	"	3.25
No. 1 White Cotton	4.25	"	4.75
No. 2 White Cotton	3.25	"	3.75
No. 3 White Cotton	2.50	"	3.00
No. 4 White Cotton	1.90	"	2.20
Extra Light Prints	2.00	"	2.40
Ord. Light Prints	1.75	"	2.15
Med. Light Prints	1.55	"	1.95
Dutch Blue Cottons	2.25	"	2.50
French Blue Linens	3.00	"	—
Checks and Blues	2.00	"	—
Linsey Garments	1.90	"	2.00
Dark Cottons	1.50	"	1.60
Old Shopperies	1.30	"	1.45
New Shopperies	1.45	"	1.50
French Blues	2.25	"	2.50

BAGGING

(Prices to Mill, f. o. b. N. Y.)

Gunny No. 1—			
Foreign	Neminal		
Domestic	4.00	@	4.25
Wool Tares, light	4.25	"	4.50
Wool Tares, heavy	4.50	"	4.75
Bright Bagging	4.50	"	4.85
Manila Rope—			
Foreign	—	"	—
Domestic	*5.75	"	—
Jute Threads	4.25	"	4.75
No. 1 Sisal Strings	*4.00	"	—
Mixed Strings	1.00	"	1.20

* OPA Maximum Price.

Old Waste Papers

(F. o. b. New York)

OPA Maximum Prices

No. 1 Hard White Envelope Cuts, one cut	3.37½	@	—
No. 1 Hard White Envelope Cuts	3.12½	"	—
No. 1 Hard White Shavings, unruled	2.87½	"	—
No. 1 Hard White Shavings, ruled	2.50	"	—
Soft White Shavings, one cut	2.87½	"	—
No. 1 Soft White Shavings	2.50	"	—
Soft White Shavings, Misc.	2.15	"	—
No. 1 Fly Leaf Shavings	1.67½	"	—
No. 2 Fly Leaf Shavings	1.12½	"	—
No. 1 Groundwood Fly Leaf Shavings	1.25	"	—
No. 2 Mixed Groundwood Fly Leaf Shavings	.90	"	—
Mixed Colored Shavings	.75	"	—
Mixed Groundwood Colored Shavings	.90	"	—
Overissue Magazines	1.67½	"	—
No. 1 Heavy Books & Magazines	1.57½	"	—
Mixed Books	.85	"	—
No. 1 White Ledger	2.17½	"	—
No. 2 Mixed Ledger, colored	1.87½	"	—
New Manila Envelope Cuttings, one cut	2.87½	"	—
New Manila Envelope Cuttings	2.65	"	—
Extra Manilas	1.85	"	—
Mixed Kraft, Env. & Bag Cuttings	2.75	"	—
Kraft Envelope Cuttings	3.25	"	—
Triple Sorted, No. 1 Brown Soft Kraft	2.50	"	—
New 100% Kraft Corrugated Cuttings	2.25	"	—
No. 1 Assorted Old Kraft	1.75	"	—
New Jute Corrugated Cuttings	.90	"	—
Old Kraft Corrugated Containers	1.50	"	—
Box Board Cuttings	.72½	"	—
White Blank News	1.65	"	—
Overissue News	.85	"	—
No. 1 News	.75	"	—
No. 1 Mixed Paper	.70	"	—
Old Corrugated Containers	.82½	"	—
Mill Wrappers	.85	"	—

Twines

(F. o. b. Mill)

(Soft Fiber)

Coarse Polished—			
India	.21	@	—
White Hemp	.21	"	—
Fine Polished—			
Fine India	.26	"	—
Unpolished—			
Box	.17¼	"	—
Paper Makers	.17	"	—
Tube Rope	.19	"	—
Wall Paper	.20½	"	—
Wrapping	.23	"	—
Soft Fiber Rope	.19	"	—
Cotton	.25	"	—

(Hard Fiber)

Medium Java	.18	"	—
Mex. Sisal	.16	"	—
Manila	—	"	—

PHILADELPHIA

Domestic Rags (New)

(Price to Mill, f. o. b. Phila.)

Shirt Cuttings—			
New White No. 1	.07¼	@	.07½
New White No. 2	.04½	"	.05
Light Silesias	.04½	"	.04¾
Silesias, No. 1	.04	"	.04¼
Black Silesias, soft	.03¾	"	.04
New Unbleached	.07¼	"	.07½
Washable Prints	.03¾	"	.03½
Washable No. 1	.02	"	.02¼
Blue Overall	.04½	"	.05½
Cottons—According to grades—			
Washable shredding	—	"	.01¾
Fancy Percales	.03¼	"	.03½
New Black Soft	.02¾	"	.03
New Dark Seconds	1.75	"	2.00
Khaki Cuttings—			
No. 1 O. D.	.03	"	.03¼
No. 2 Mixed	.02¼	"	.02½
Corduroy	.01¾	"	.02¼
New Canvas	.04¾	"	.05¼
New Black Mixed	—	"	.02½

Domestic Rags (Old)

White No. 1—Repacked	3.80	"	—
White No. 2—Repacked	2.90	"	—
Miscellaneous No. 1	3.20	"	—
Miscellaneous No. 2	2.65	"	—
Thirds and Blues—			
Miscellaneous	1.80	"	—
Repacked	2.20	"	—
Black Stockings—			
(Export)	Nominal		
Roofing Stock—			
Foreign No. 1	Nominal		
Domestic No. 1	1.55	"	—
Domestic No. 2	1.45	"	—
Roofing Bagging	1.35	"	—
Old Manila Rope	5.75	"	—

Bagging

(F. o. b. Phila.)

Gunny No. 1—			
Foreign	Nominal		
Domestic	3.00	"	3.50
Sisal Rope	3.75	"	—
Mixed Rope	.75	"	1.00
Scrap—			
No. 1	3.25	"	3.50
No. 2	1.75	"	1.80
Wool Tares, heavy	4.00	"	4.25
No. 1 New Light Burlap	3.00	"	4.00
New Burlap Cuttings	3.75	"	4.00

Old Papers

(F. o. b. Phila)

OPA Maximum Prices

No. 1 Hard White Envelope Cuts, one cut	3.37½	"	—
No. 1 Hard White Shavings, unruled	2.87½	"	—
Soft White Shavings, one cut	2.50	"	—
White Blank News	1.65	"	—
Soft White Shavings, Misc.	2.15	"	—
No. 1 White Ledger	2.17½	"	—
No. 2 Ledger, colored	1.87½	"	—
No. 1 Heavy Books & Magazines	1.57	"	—
Overissue Magazines	1.67½	"	—
New Manila Envelope Cuttings	2.65	"	—
No. 1 Assorted Old Kraft	1.75	"	—
No. 1 Mixed Paper	.70	"	—
Box Board Cuttings	.72½	"	—
Jute Corrugated Cuttings	.90	"	—
Overissue News	.85	"	—
No. 1 News	1.00	"	—

BOSTON

Old Papers

(F. o. b. Boston)

OPA Maximum Prices

No. 1 Hard White Shavings, unruled	2.87½	@	—
No. 1 Hard White Shavings, ruled	2.50	"	—
Soft White Shavings, Misc.	2.15	"	—
No. 1 Fly Leaf Shavings	1.67½	"	—
No. 2 Fly Leaf Shavings	1.12½	"	—
No. 1 Groundwood Fly Leaf Shavings	1.25	"	—
No. 2 Groundwood Fly Leaf Shavings	.90	"	—
Mixed Colored Shavings	.75	"	—
New Manila Envelope Cuts, one cut	2.87½	"	—
Hard White Envelope Cuts, one cut	3.37½	"	—
Triple Sorted No. 1 Brown Soft Kraft	2.50	"	—
Mixed Kraft Env. & Bag Cuttings	2.75	"	—
Kraft Envelope Cuttings	3.25	"	—
No. 1 Heavy Books & Magazines	1.57	"	—
New Manila Envelope Cuts, one cut	2.87½	"	—
New Manila Envelope Cuttings	2.65	"	—
White Blank News	1.65	"	—
No. 1 Assorted Old Kraft	1.75	"	—
No. 1 Mixed Paper	.70	"	—
Overissue News	.85	"	—
Box Board Cuttings	.72½	"	—
New Corrugated Cuttings, Kraft	2.25	"	—
Old Corrugated Containers	1.00	"	—
Jute Corrugated Cuttings	1.07½	"	—

Bagging

(F. o. b. Boston)

Gunny Bagging—			
Foreign	(nominal)		
Domestic	3.75	@	4.00
Sisal Rope No. 1	*4.75	"	—
Sisal Rope No. 2	*4.25	"	—
Mixed Rope	1.35	"	1.50
Transmission Rope—			
Foreign	(nominal)		
Domestic	2.75	"	3.00
Manila Rope—			
Foreign	(nominal)		
Domestic	5.75	"	—
Soft Jute Rope	4.50	"	5.00
Jute Carpet Threads	3.00	"	3.50
Bleachery Burlap	8.50	"	9.00
Scrap Burlap—			
Foreign	(nominal)		
Domestic	3.60	"	3.85
Wool Tares—			
Foreign	(nominal)		
Domestic	4.25	"	—
Aust. Wool Pouches	4.65	"	4.87½
New Burlap Cuttings	4.75	"	5.00
Heavy Baling Bagging	4.00	"	4.25
Paper Mill Bagging	2.50	"	3.00
No. 2 Bagging	1.35	"	—

* OPA Maximum Price.

Domestic Rags (New)

(F. o. b. Boston)

Shirt Cuttings—			
New Light Prints	.04½	@	.04¾
Fancy Percales	.04¾	"	.05
New White No 1.	.06¾	"	.07
New Light Flannelettes	.05½	"	.06
Canton Flannels, Bleached	.06	"	.06½
Underwear Cutters, Bleached	.06¾	"	.06¾
Underwear Cutters, Unbleached	.05¾	"	.06
Silesias No. 1	.06	"	.06¼
New Black Silesias	.03	"	.03½
Red Cotton Cuttings	.03½	"	.04
Soft Unbleached	.06½	"	.06¾
Blue Cheviots	.05½	"	.06
Fancy	.02¾	"	—
Washable	.02¾	"	—
Khaki Cuttings	.02¾	"	.03
O. D. Khaki	.03½	"	.03¾
Corduroy	.03¼	"	.03½
New Canvas	.06¼	"	.06¾
B. V. D. Cuttings	.06¾	"	.06¾

Domestic Rags (Old)

(F. o. b. Boston)

White No. 1—			
Repacked	3.80	@	—*
Miscellaneous	3.20	"	—*
White No. 2—			
Miscellaneous	2.65	"	—*
Twos and Blues, Repacked	2.20	"	—*
Old Blue Overalls	2.25	"	2.50
Thirds and Blues, Repacked	2.20	"	—*
Miscellaneous	1.80	"	—*
Black Stockings	3.50	"	4.00
Roofing Stock—			
No. 1	1.55	"	—*
No. 2	1.45	"	—*
No. 3	1.35	"	—*
No. 4	1.35	"	—*
No. 5, Quality A	1.35	"	—*
Quality B	1.20	"	—*
Quality C	.95	"	—*
* Old Manila Rope	5.75	"	—

* OPA Maximum Prices.

Foreign Rags

(F. o. b Boston)

Canvas	(nominal)
Dark Cottons	(nominal)
Dutch Blues	(nominal)
New Checks and Blues	(nominal)
Old Fustians	(nominal)
Old Linsey Garments	(nominal)
New Silesias	(nominal)

CHICAGO

Waste Paper

(F. o. b. Chicago)

OPA Maximum Prices.

Shavings—			
No. 1 Hard White Envelope Cuts, one cut	3.37½	"	—
No. 1 Hard White Shavings, unruled	2.87½	"	—
No. 1 Soft White Shavings	2.50	"	—
No. 1 White Ledger	2.17½	"	—
No. 1 Heavy Books & Magazines	1.67½	"	—
White Blank News	1.65	"	—
Mixed Kraft Env. & Bag Cuttings	2.75	"	—
No. 1 Assorted Old Kraft	1.75	"	—
Overissue News	.85	"	—
No. 1 News	.75	"	—
No. 1 Mixed Paper	.70	"	—
No. 1 Roofing Rags	1.55	"	—
No. 1 Roofing Bags	1.45	"	—